SCIENTIFIC AMERICAN SUPPLEMENT No. 201

Scientific American Supplement, Vol. VII., No. 201.
Scientific American, established 1845.

NEW YORK, NOVEMBER 8, 1879.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

PLOWING BY ELECTRICITY.

The question of transmission of power by means of electricity is not entirely a new one, since several individuals have been devoting considerable attention to it for some years past. Recently, however, new and important results have been attained, and there is everything to make us hope that progress will now be rapid, and soon lead to still other and more important applications of this physical agent.

MM. Chretien and Felix, two well-known French engineers, who have kept themselves well informed in regard to the labors of M. Gramme and the former applications of his machine, have begun a series of applications that are still more important than any that have preceded them. Last year these gentlemen used a combination (based on that formerly employed by M. Cadiat) for unloading beet boats and loading wagons at the sugar works of Sermaize, in Marne. A Gramme machine was made to turn, by means of a belt, a large wheel, which carried an endless chain of buckets, and similar to that used on dredges. The chain ran down into the boat, where six workmen loaded the buckets with the beets that were to be hoisted. The chain worked continuously, and the buckets, as fast as they reached the proper point, dumped the beets automatically into an inclined hopper, through which they were carried to the wagons in waiting. During the season of 1878–79 there were unloaded in this way four hundred tons of beets, which had been brought to the port of Sermaize by boats on the canal from the Marne to the Rhine. The governing Gramme machine was situated in the Sermaize Sugar Works at a distance of about 325 feet from the port, the two machines being connected by wires carried on posts. The use of this apparatus was found to effect the saving of about 40 per cent. over manual labor.

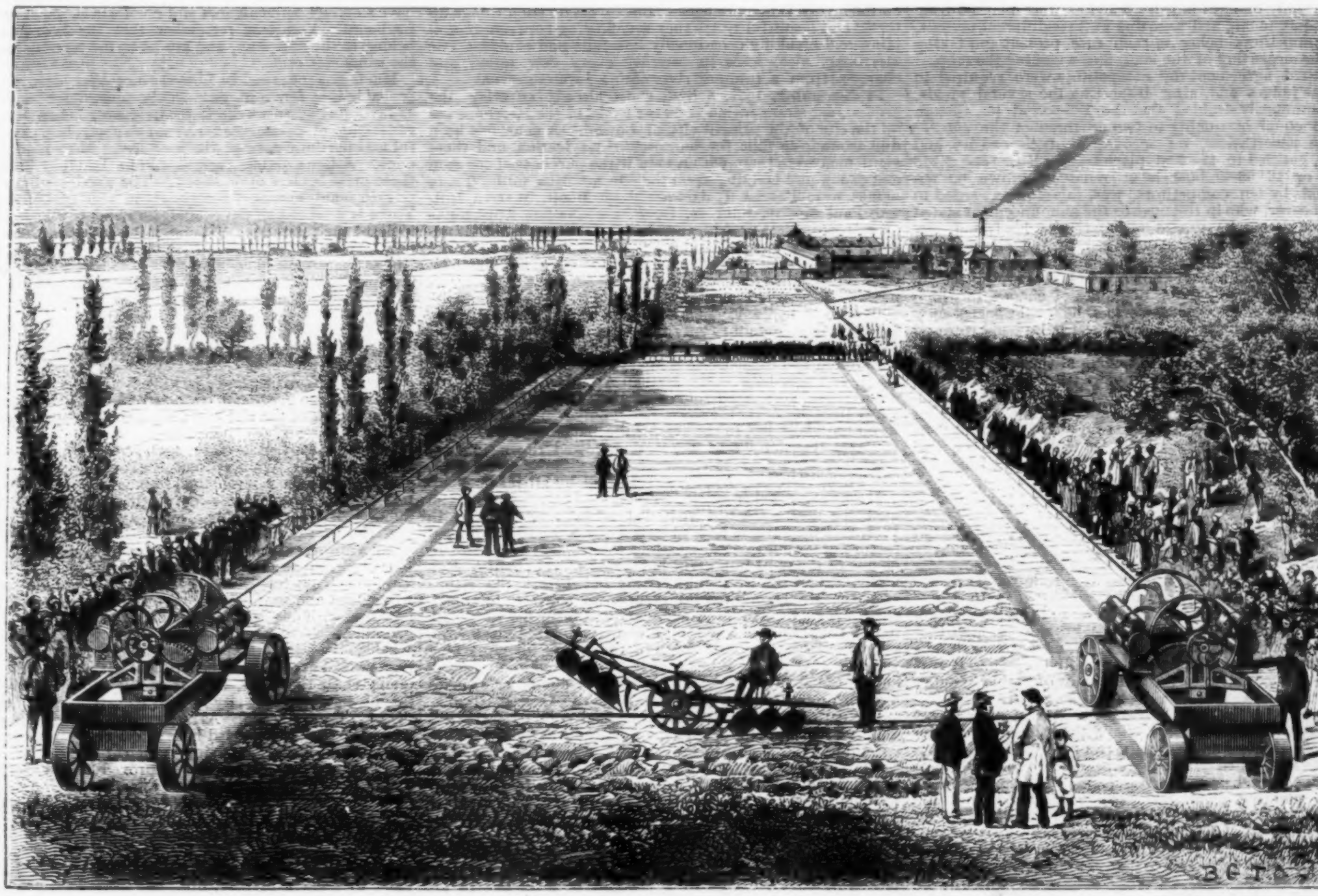
MM Chretien and Felix have since gone still farther by exhibiting (also at Sermaize) a device for plowing by electricity. These practical experiments were witnessed by a great number of scientists, and have greatly attracted the attention of the public generally. We will endeavor to give some idea of them.

The general principle is the same as in the preceding case: A governing Gramme machine occupies a fixed position in the sugar works, and is actuated by a steam engine. The electricity thereby developed is led by conducting wires, first to one windlass and then to another. These two windlasses, mounted on four-wheeled carriages, are seen at the right and the left of the field in the accompanying engraving. By means of a small steel cable, half an inch in diameter, these windlasses alternately draw back and forth over the field a balance plow provided with four shares, two working in each direction. Motion is given to the windlasses by two Gramme machines, placed at the right and left, and which the reader will at once recognize in the engraving. The mechanical arrangement is very simple. Each of the two Gramme machines carries two pulleys, covered with India rubber, and which press against and move the two large pulleys of the hauling apparatus by friction. The two machines are connected together at their upper parts by means of a simple connecting rod and a pair of India rubber rings, which hold the pulleys on the ends of the Gramme machine against the large pulleys of the windlass.

The apparatus works in the following way: The electric current being led from the factory through the two conducting cables, causes the Gramme machines to revolve. The friction pulleys on the ends of the latter move the large pulleys, and these in turn communicate movement to the hauling drum by means of pinions fixed on their axle. The hauling drum, by means of its steel cable, carries the plow. When the latter has crossed the field a commutator is turned, the current reversed, the other windlass set in motion, and the plow thus carried back to its former position. In the experiment at Sermaize the two windlasses were placed at a distance of 664 feet apart, and the 8-horse power engine which gave motion to the dynamo-electric machines which supplied the electricity was situated at 1,300 feet from the field. The Gramme machines at the works were driven at 1,600 revolutions per minute, while those on the windlasses made 800 per minute. The hauling drums made 14 and 27 revolutions per minute under the slow and fast speeds respectively, the corresponding speeds of the plow being 164 and 266 feet per minute. It was found that about 50 per cent. of the work of the fixed engine was realized on the field, and that the efficiency of the electro-dynamic apparatus is from 30 to 60 per cent., according to the distance of transmission.

Another feature connected with the apparatus remains to be mentioned. The wagons which carry the windlasses are themselves moved by electricity after the plowing of every double furrow. This is effected as follows: Upon a prolongation of the main axle of the machine is fixed a bevel pinion, which gears with a bevel wheel at the end of the wagon; the shaft of the bevel wheel carries a pitch pinion, and over this and a cog wheel on the hind axle of the wagon runs a pitch chain. By a simple shifting of the gearing, motion is transferred from the windlass to the latter system and a headland movement of the wagon obtained. The steering of the wagon is effected by a hand wheel in front.

It is urged in favor of this apparatus that it will provide in France the means of supplanting much hand labor, which is scarce, expensive, and not always to be depended upon; and that by its means much water power, now neglected, may be turned to profitable advantage in actuating the machines for producing and transmitting the electricity.



PLOWING BY ELECTRICITY.—(Experiments made at Sermaize, France, May 22, 1879.)

A NOVEL POTATO CONTEST.

A novel contest in the culture of the potato has been going on the past summer among a few members of the Franklin, Mass., Farmers' Club, which may prove of interest to others outside the association. The contest was started by Monroe Morse, a successful cultivator of this crop, who challenged any or all the members of the club to compete with him for the largest and best crop of potatoes grown upon a single square rod of ground, the competitor who should show the best yield being entitled to the product of all the other competing rods—size and smoothness both to be considered. Competitors were required to plant from the same lot of seed, a barrel of Early Rose purchased in Boston being provided by the challenger for that purpose. Rules for measuring the ground were adopted, and each planter was restricted from planting nearer to the outside lines than allowed by the rules, unless he chose to select a rod from a potato field, in which case the lines must extend only to the middle of the adjoining spaces between the rows. Ten members accepted the challenge, making the number of competitors eleven. The potatoes grown were placed on exhibition at the meeting of the club, at the residence of Wm. E. Nason, October 4, and statements concerning the methods of culture placed on file with the secretary. The reports show as wide a difference in the methods adopted as in the quantity and quality of the crops presented. Below we give the names of the competitors, with the number of pounds grown by each, commencing with the smallest yield:

S. F. Sargent	38½	pounds.
A. C. Bullard	56	"
Wm. Mann	76	"
Wm. Adams	78	"
G. S. Hancock	91	"
Monroe Morse	93	"
James Hood	125¼	"
Alfred Clark	132	"
S. W. Squire	150	"
A. W. Cheever	183	"

V. R. Warren was a competitor, but by mistake his rod was dug and the potatoes consumed without weighing. The small yields obtained by Messrs. Sargent, Bullard, Mann, Hancock, and Morse were due solely to the failure of the seed in germinating—more than half of Mr. Sargent's

failing to grow, and nearly half of those planted by Messrs. Bullard, Mann, Hancock, and Morse. To promote smoothness, Mr. Sargent laid rye straw in the bottom of the drills, planting the sets upon the top and then covering with soil. For the same purpose Mr. Bullard used forest leaves in the bottom of his drills. As the season was dry at the time of planting, and for some time afterward, this proved a serious damage, although the quality of their product was unexcelled. Messrs. Hancock, Clark, Adams, and Hood depended chiefly upon stable manure, while Messrs. Morse, Bullard, Sargent, Squire, Mann, and Cheever used principally guano and other commercial fertilizers. Mr. Adams, we believe, applied considerable potash in the form of spent lye, and from this or other causes had a very inferior crop of scabby potatoes. Mr. Squire used Peruvian guano at the rate of 800 pounds per acre, and sulphate of potash 200 pounds per acre. Mr. Hancock applied a two-horse cart load of stable manure to the rod, plowed in, and nine pounds guano sprinkled in the hills. Mr. Cheever plowed in a light coat of manure, and applied guano and sulphate of potash, at the rate of 1,000 pounds of the former and 400 of the latter per acre. Mr. Morse used 800 pounds of guano and 200 pounds of potash per acre. Mr. Clark applied stable manure freely and watered the ground occasionally after the potatoes were growing, with a solution of hog manure and poultry droppings. Mr. Hood used a spoonful of Bradley's superphosphate in the hill. Messrs. Hancock, Hood, and Adams had each about fifty hills, while Mr. Clark had 125 hills. Mr. Squire planted in five double rows or drills, the seed being just twelve inches apart each way, with room for horse cultivation between. Mr. Morse practiced horse cultivation exclusively, never using a hand hoe at all, either in covering or tending the crop, while Messrs. Clark, Hood, and Cheever cultivated by hand exclusively. Mr. Squire cut his seed in halves, planting one piece in a place. Mr. Mann used pieces with two eyes, while most of the others were cut to single eyes. Mr. Hood cut his seed two weeks before planting, and found it much dried, but only one hill failed. The lots were planted from May 6th to June 8th, and were dug at three different periods, several competitors being in each case present and taking part in the measuring of the land, and weighing the crop.

By mutual agreement the competitors were required to act also as judges, and, after inspecting the several yields, they unanimously decided that the 183-pound lot, though not quite equal in quality to two or three of the smaller lots, was nevertheless, on account of both quality and quantity, entitled to the first place on the list. The 1,013 pounds, or 16 53-60 bushels of potatoes, grown on ten square rods by ten competitors, was, therefore, awarded to A. W. Cheever, who in response to the announcement stated that although at the urgent solicitation of his friend, Mr. Morse, the challenger, he had joined in the competition, and had done his best to give some one a handsome yield of potatoes, yet with his well-known views concerning the injurious tendency of all forms of games of chance in which one man's luck is another man's loss, he could accept only those grown upon his own plot; and as parties had expressed a desire to secure seed for planting from these trial lots, he would direct that they be sold at auction, the proceeds to be placed in the treasury of the club, to be used toward paying for a lecture during the coming winter. The other competitors agreeing to the same arrangement, the whole lot was sold, netting to the club the sum of $11.47, thus closing a competitive trial in which valuable experience had been gained by all and without loss to any. The following is the

STATEMENT OF A. W. CHEEVER.

The land on which I grew the trial rod of potatoes has been under cultivation several years, producing chiefly forage crops. Last year it produced a crop of rye fodder and a crop of oat fodder, and these were followed by a crop of barley, each crop being manured either with stable manure or commercial fertilizers. The soil is a heavy loam exposed to the East, quite moist early in the season, so that an early plowing caused it to form somewhat into lumps which remained unpulverized during the season. It was plowed but once this year, a light coat of stable manure being turned in about seven inches deep. This was somewhat mixed with the soil by deep cultivation after plowing. The rows were marked out with a large cultivator tooth about eighteen inches apart, run quite shallow, so that the potato sets, when planted, were scarcely below the surface of the ground.

Before planting, about 800 pounds of guano, and 400 pounds of sulphate potash, per acre, were spread broadcast over the furrows. The seed was prepared by exposure several days to a strong light, to start the sprouts into a short, healthy growth. When ready to plant, single eyes were cut from the seed, selecting only those which were well started and of good, strong appearance. Most of the eyes were cut from the stem end or middle of the potato, where considerable potato could be taken out with each eye. As they were cut, they were laid in a basket, with plaster dusted over them in sufficient quantity to cover the cut surface, and to partially protect the sprouts from bruising while being handled. The pieces were dropped singly, and about fourteen inches apart, the whole amount of ground planted in this way being from two to three rods.

The sets were covered by hand not over an inch deep. Just as the shoots were breaking ground, the plot was dusted over with guano, at the rate of 200 pounds per acre, and then raked into the soil with a garden rake, killing, at the same time, all the small weeds which had started. As the potatoes were so near the surface, and so thickly planted, it was found impracticable to hill them in the ordinary way, so the ground was mulched with chopped straw for a protection, not only against weeds, but to keep the new potatoes from being sunburnt as they showed themselves above the surface. The mulch also, in a measure, secured a cool, moist soil during the hot, dry weather of midsummer. The straw was put on some three inches deep, but soon settled to one inch, and was then covered with a second coat of mulch which remained undisturbed till digging time.

To keep the bugs in check, a sprinkling of dry plaster was used three or four times, with just enough Paris green to shade the plaster, giving it a slight greenish tinge. A very few weeds were pulled by hand during the season of growth, but it was the aim to travel over the patch just as little as possible, as the plants covered nearly the whole surface. The rod of land was measured off from near the center of the patch, at digging time, by Horace Morse and S. W. Squire, and the potatoes weighed by Mr. Morse, who certifies that there were 183 pounds—a yield per acre equal to 488 bushels. The most important lesson I have learned by the experiment is that potatoes *must* have room to grow *under* ground, or the yield will be diminished and the quality impaired. I would never plant so near the surface again, and with an equally favorable season should expect to do better another year.—*New England Farmer.*

THE FOUNDING OF LOWELL.

By James Parton.

We do not often hear of strikes at Lowell. Some men tell us it is because there are not as many foreigners there as at certain manufacturing centers where strikes are frequent. This cannot be the explanation; for out of a population of forty-five thousand, there are sixteen thousand foreign-born inhabitants of Lowell, of whom more than ten thousand are natives of Ireland. To answer the question correctly, we must perhaps go back to the founding of the town in 1821, when there were not more than a dozen houses on the site.

At that time the great water power of the Merrimac River was scarcely used, and there was not one cotton manufactory upon its banks. At an earlier day this river and its tributaries swarmed with beaver and other fur-yielding creatures, which furnished a considerable part of the first capital of the Pilgrim Fathers. The Indians trapped the beaver, and carried the skins to Plymouth and Boston; and this is perhaps the reason why the Merrimac and most of its branches retain their Indian names. Merrimac itself is an Indian word meaning sturgeon, and of its ten tributaries all but two appear to have Indian names: Contoocook, Soucook, Suncook, Piscataguog, Souhegan, Nashua, Concord, Spiggot, Shawshine, and Powow.

Besides these there are the two rivers which unite to form it, the names of which are still more peculiar: Pemigewasset and Winnepiseogee. The most remarkable thing with regard to these names is, that the people who live near see nothing remarkable in them and pronounce them as naturally as New Yorkers do Bronx and Croton. It is difficult for us to imagine a lover singing or saying, "Meet me by the Pemigewasset, love," or asking her to take a row with him on the lovely Winnepiseogee. But lovers do such things up there; and beautiful rivers they are, flowing between mountains, and breaking occasionally into falls and rapids. The Merrimac, also, loses its serenity every few miles, and changes from a tranquil river into a—water-power.

In November, 1821, a light snow already covering the ground, six strangers stood on the banks of the Merrimac upon the site of the present city of Lowell. A canal had been dug around the falls for purposes of navigation, and these gentlemen were there with a view to the purchase of the dam and canal, and erecting upon the site a cotton mill. There names were Patrick T. Jackson, Kirk Boott, Warren Dutton, Paul Moody, John W. Boott, and Nathan Appleton—all men of capital or skill, and since well known as the founders of a great national industry. They walked about the country, observed the capabilities of the river, and made up their minds that that was the place for their new enterprise.

"Some of us," said one of the projectors, "may live to see this place contain twenty thousand inhabitants."

The enterprise was soon begun. In 1826 the town was incorporated and named. It is always difficult to name a new place, or a new baby. Mr. Nathan Appleton met one of the other proprietors, who told him that the legislature was ready to incorporate the town, and it only remained for them to fill the blank left in the act for the name.

"The question," said he, "is narrowed down to two, Lowell or Derby."

"Then," said Mr. Appleton, "Lowell by all means."

It was so named from Mr. Francis C. Lowell, who originated the idea. He had visited England and Scotland in 1811, and while there had observed and studied the manufacture of cotton fabrics, which in a few years had come to be one of the most important industries of the British Empire. The war of 1812 intervened; but, before the return of peace Mr. Lowell took measures for starting the business in New England. A company was formed with a capital of four hundred thousand dollars, and Mr. Lowell himself undertook the construction of the power loom, which was still guarded in Europe as a precious secret. After having obtained all possible information about it, he shut himself up in a Boston store with a man to turn his crank, and experimented for months till he had conquered the difficulties. In the fall of 1814 the machine was ready for inspection.

"I well recollect," says Mr. Appleton, "the state of admiration and satisfaction with which we sat by the hour watching the beautiful movement of this new and wonderful machine, destined as it evidently was to change the character of all textile industry."

In a few months the first manufactory was established in Waltham, with the most wonderful success. Henry Clay visited it, and gave a glowing account of it in one of his speeches, using its success as an argument against free trade. It is difficult to see what protection the new manufacture required. The company sold its cotton cloth at thirty cents a yard, and they afterward found that they could sell it without loss at less than seven cents. The success of the Waltham establishment led to the founding of Lowell, Lawrence, Nashua, and Manchester. There are now at Lowell eighty mills and factories, in which are employed sixteen thousand men and women, who produce more than three million yards of fabric every week. The city has a solid, inviting appearance, and there are in the outskirts many beautiful and commanding sites for residences, which are occupied by men of wealth.

But now as to the question above proposed. Why are the operatives at Lowell less discontented than elsewhere? It is in part because the able men who founded the place bestowed some thought upon the welfare of the human beings whom they were about to summon to the spot. They did not, it is true, bestow thought enough; but they *thought* of it, and they had some provision for proper and pleasant life in their proposed town. Mr. Appleton, who many years ago took the trouble to record these circumstances, mentions that the probable effect of this new kind of industry upon the character of the people was most attentively considered by the founders. In Europe, as most of them had personally seen, the operatives were unintelligent and immoral, made so by fifteen or sixteen hours' labor a day and a beer shop on every corner. They caused suitable boarding-houses to be built, which were placed under the charge of women known to be competent and respectable. Land was assigned and money subscribed for schools, for churches, for a hospital. Systematic care was taken to keep away immoral persons, and rules were established, some of which carried the supervision of morals and manners perhaps too far. The consequence was that the daughters of farmers, young women well educated and well-bred, came from all quarters, and found the factory life something more than endurable.

But for one thing they would have found it salutary and agreeable. The plague of factory life is the extreme monotony of the employment, and this is aggravated in some mills by high temperature and imperfect ventilation. At that time the laws of health were so little understood that few persons saw any hardship in young girls standing on their feet thirteen, fourteen, fifteen, and even sixteen hours a day! It was considered a triumph when the working-day was reduced to thirteen hours. Thirty years ago, after prodigious agitation, the day was fixed at eleven hours. That was too much. It has now been reduced to ten hours; but it is yet to be shown that a woman of average strength and stamina can work in a cotton mill ten hours a day for years at a stretch, without deteriorating in body, in mind, or in character.

During the first years the girls should come from the country, work in the mill a few months, or two or three years, and than return to their country homes. Thus the injury was less ruinous than it might have been. The high character of the Lowell operatives was much spoken of in the early day. Some of the boarding-houses contained pianos upon which the boarders played in the evening. A magazine, called the *Lowell Offering*, was sustained by them for several years. I have before me at this moment the number for August, 1844. It is a very neat and creditable production, filled with poetry, stories, and sketches, written by the "mill girls," as they termed themselves. The most interesting article in this number is one of a series of "Letters from Susan," in which the writer gives a very amiable and interesting account of mill life. According to Susan, the mills themselves were pleasant places, the rooms being "high, very light, kept nicely whitewashed, and extremely neat, with many plants in the window-seats, and white cotton curtains to the windows."

"Then," says Susan, "the girls dress so neatly, and are so pretty. The mill girls are the prettiest in the city. You wonder how they can keep so neat. Why not? There are no restrictions as to the number of pieces to be washed in the boarding-houses. You say you do not see how we can have so many conveniences and comforts at the price we pay for board. You must remember that the boarding-houses belong to the company, and are let to the tenants far below the usual city rents."

Much has changed in Lowell since that day, and it is probable that few mill girls would now describe their life as favorably as Susan did in 1844. Nevertheless, the present generation of operatives derive much good from the thoughtful and patriotic care of the founders. More requires to be done. A large public park should be laid out in each of those great centers of industry. The abodes of the operatives in many instances are greatly in need of improvement. There is need of half-day schools for children who are obliged to assist their parents. Wherever it is possible, there should be attached to every house a piece of ground for a garden. The saying of the old philosopher is as true now as it was in the simple old times when it was uttered: "The way to have good servants is to be a good master."—*New York Ledger.*

AMERICAN POTTERY INTEREST.

John A. Norton, Esq., writing from East Liverpool, O., to the Chicago *Journal of Commerce*, gives a full and interesting sketch of the rise and progress of the pottery interest at that place, and continues.

In ceramic art, East Liverpool occupies much the same relation to this country that Staffordshire does to Great Britain. She has eleven Rockingham and yellow ware potteries, with twenty-six kilns; eight potteries for the production of ironstone china, with twenty-nine kilns; four potteries for the manufacture of "C. C.," or cream-colored ware, with ten kilns; two knob potteries, with three kilns; four decorating establishments—including one with Knowles, Taylor & Knowles—with six kilns; one flint and spar mill, where flint and spar are ground and prepared ready for potters' use, with one kiln for calcining the work preparatory to grinding. Here are altogether twenty-six potteries, with seventy-five kilns. Most of the kilns erected during the last two years have been fifteen to sixteen and a half feet in diameter in the clear, and from fifty to sixty-five feet in height, having a capacity to hold from 2,500 to 3,200 dozen pieces of ware each. A factory for the manufacture of encaustic tiles was started here a few years ago, but the parties controlling it not having sufficient capital to carry on the business with strength, it proved unsuccessful. The works have been converted into a factory for the production of C. C. ware. Over $1,000,000 are employed in the industry, nearly 2,000 hands, and the works have a productive capacity exceeding $1,500,000 per annum. The extensive additions recently made to old works, and the building of new ones here and in other places, afford great encouragement to owners of clay, flint, and spar mines, whose products enter into the manufacture of white ware, to properly develop them and provide for the greatly increased demands now thrust upon them. One of the strongest arguments in favor of stability and permanence in the protective policy lies in the fact that often a heavy capital must be expended in developing mines to furnish the raw material for manufacture, and owners of clay, flint, and spar mines have been reluctant to expend the money necessary for their proper development, fearing that, by the time they had done so, a free-trade congress would reduce duties upon crockery ware, rendering the continuance of the business unprofitable, their investments valueless, and themselves bankrupt.

Our country is wonderfully rich in the raw materials needed for the manufacture of earthen and china ware, and if our tariff is maintained, and the duties honestly collected, the next fifteen years will witness the development of the manufacture of fine china ware on a scale corresponding to that already realized and now going forward with such grand strides in the manufacture of ironstone china.

The States of Illinois, Indiana, Missouri, and several Southern States, have clays of superior quality for producing the most delicate china ware that can be made; but with a lowering of the tariff we may bid good-by to our hopes of having that valuable industry naturalized upon our soil on an extensive scale for many years to come, much as the system is vaunted in certain quarters.

Two centuries of free trade would not have witnessed the development in our country of the ceramic art to the point to which it has now attained. More than half of the hands employed in the potteries are American-born, and those apprenticed and trained under the eye and supervision of the potters make excellent workmen. The ceramic art is a difficult one to carry to a high standard of excellence, and every skilled workman therein ought to have an eye and hand trained in the arts of design and become acquainted with chemistry. The master potters, of course, suffer greatly for the want of a wise and proper apprentice law, but the youth of the land suffer a thousand-fold worse. With the

former it is pecuniary loss chiefly, while to thousands of our youth it results in ruin for life, and becomes a curse to the land, as the crowded condition of our prisons prove. Some foreign-born workmen resisted the introduction of improved mechanism for a time, but the trouble was of short duration.

The introduction of improved machinery and processes of manufacture has given a great impetus to the development of the industry throughout the country. The capital now invested in the pottery industry here is nearly all of home growth—only a small proportion having been brought from outside. As the business grew and increased the potters turned their profits right back upon their respective works, enlarging them and improving their facilities for production, and mortgages upon works have been few in number and are now scarcely known. It is a remarkably self-contained, independent community, and calls no man or set of men master; and a striking proof of its solidity and strength is found in the fact that no failure of any magnitude, either among the potters or merchants, has taken place during all these panic years. That revolution proved a blessing in disguise to the pottery industry, in crippling the merchants of the country almost universally, so that each was in a brown study how to lessen the amount of capital constantly invested in stock which they were obliged to carry. Staffordshire and other foreign centers of crockery manufacture in the Old World were several thousand miles distant, and in order to keep a constant supply of goods of foreign make stocks must be large, involving a heavy outlay of capital, and consequent loss of interest. The American potters said to these panic-stricken merchants: "We are making good ware, and guarantee every piece. You can reach us daily and hourly by telegraph, if need be, and at small cost, to renew your stocks, and we will carry your stock for you, and you need to keep little more than a set of samples while these hard times continue." The offer was accepted, and in great numbers of cases merchants learned of the excellence of our American-made ware, as it were, upon compulsion of stern necessity. So, as the months passed into years, these merchants found that the ware which they had bought from these American manufacturers gave excellent satisfaction. They have gradually become enthusiastic in their admiration of American pottery. The potters both here and at Trenton have wisely employed traveling salesmen to present their ware to the merchants of the country and make them acquainted with its merits, and it is to be hoped that they will continue to do so until every merchant, not only in our own country, but on the American continent, shall be made acquainted with the excellence of American ware.

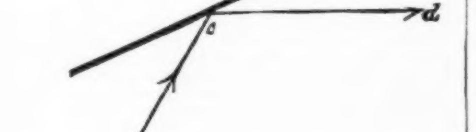
THE POLARISCOPE AS APPLIED TO SUGAR MANUFACTURING AND BREWING.

By J. STEINER.

I HAVE often been asked, when working with the polariscope, to explain the principles which govern it and permit its application for the determination of the different sugars familiar to us, and why it has become of such importance to the manufacturer and refiner of cane sugar; and I am confident it will also be used by the brewer as soon as he is acquainted with the simplicity, exactness, and rapidity of its working in ascertaining the amount of dextrin, which dextrin is not only a very valuable constituent in brewing, but also characterizes by its presence beer, and distinguishes it from all other alcoholic beverages. In the following I will endeavor to explain the principles on which such instruments are constructed on the Continent, and then describe their application.

An ordinary or common ray of light appears to us to possess always the same qualities, from which ever standpoint we direct our eyes, *e. g.*, if we throw a ray on to a mirror it is reflected under any inclination of the glass. This, however, is not the case with all rays, as there are some which do not exhibit this property of being reflected in every direction, and this peculiarity is called in science polarization, and rays having this singular and exceptional behavior are called polarized rays. Malus (1811) was the first to discover or observe this, and in order to understand clearly the nature of polarized light, let us consider how such light can be produced, and then by what experiments the qualities of such rays can best be demonstrated.

If a ray of sunlight, *a b*, fall on to a plane glass mirror under an angle of 35° 25′ it will be reflected in the ordinary



manner, *i. e.*, it will go forth again under the same angle in the opposite direction, *b c*; but this reflected ray is now polarized, because if a second mirror be interposed it will only be again reflected provided the two mirrors be parallel. On turning the second mirror round about *b c* as axis, and always under the same angle of 35° 25′ the ray, *c d*, will decrease in intensity and disappear completely when the rotation amounts to 90°; but on continuing the motion the light again appears gradually and will be reflected with the original intensity or brightness at 180° distance from the starting point. In this position the planes of the mirrors are parallel again.

An apparatus provided with two such glass mirrors under the required inclination is the simplest form of a polariscopical instrument. The lower mirror is called the polarizer, and the upper one the analyzer. If the ray, *a b*, meet the mirror under another angle than the one given above, then only a partial polarization takes place, *i. e.*, the light is in no position of the analyzer quite extinct, although a maximum and minimum of the intensity be noticed.

The angle for which the polarization is a complete one is noted as the polarizing angle of the particular substance under examination, and it varies considerably with different bodies. As we have seen, this polarization is caused by reflection, yet such light can also be produced by other means. If light fall on to a transparent glass plate under the same angle of 35° 25′ it is partly reflected, *i. e.*, it goes back into the old medium, and another part of it passes into the new medium, and is refracted or bent out of its original direction. These latter rays are now also partly polarized, and this property can be increased by making the light pass through a system of such plates held parallel to the first plate. A number of eight or ten plates produces a very distinct polarized light, and the plane of polarization of the refracted rays is rectangular to the one of the reflected rays; hence if such a system of glass plates be used as analyzer, the apparatus will be bright when the plates are rectangular to the position of the mirror, and it will appear dark when the polarizer and this analyzer are parallel.

This is the case with single refraction, but there are instances where a ray, on passing into a new medium, is split up in two rays. This property, which is called "double refraction," was first noticed with the Iceland spar or calc spar. It crystallizes in rhombs, and on placing a rhomb

FIG. 1.

over a mark or line on white paper and looking through it the object is seen double. Again, if we cover the upper plane of such a crystal with a cardboard, having a small hole in it for a ray of light to pass through, there will appear on the plane opposite to the first one, two white points, hence there are two rays moving along in the crystal in different directions. On studying the properties of these two rays it will be found that both are polarized. To prove this we look through a prism cut of Iceland spar on to an object, and, as explained before, two distinct pictures will be seen. If now an analyzing system of glass plates, or a plate of tourmaline, which acts in like manner, be interposed between the eye and the prism, a position can be found where only one of the two pictures is to be seen, and on rotating the analyzer, always in the same plane, the other ray will be noticed as well, but on continuing the rotation the first picture fades, while the other increases in intensity, and at 90° from the starting point of rotation only the second picture remains visible.

It is therefore clear that both rays are polarized, and further, that the planes of polarization are rectangular to each other. As all the rays which pass a double refractory crystal are polarized, it is more advantageous to use prisms made from such crystals instead of mirrors in the polariscope. But as there are two systems of polarized rays always present in the crystal, which are very confusing for the observer, it occurred to Nicol to eliminate one system by combining two such crystals, cut in a certain direction, with Canada balsam, and producing by it a total reflection for the one set of rays, whereby they pass out of the field of sight for the observer. The production of light or darkness can, of

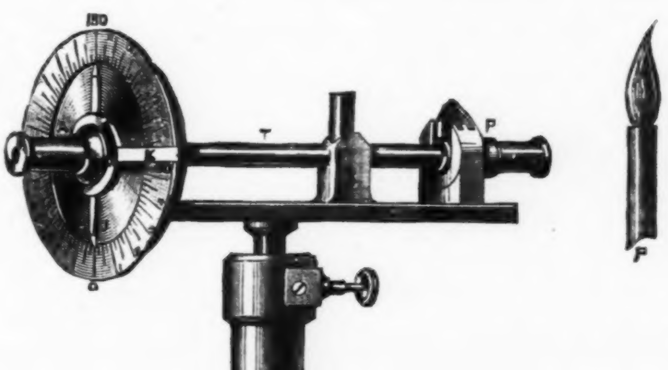


FIG 3

course, be altered or fixed at will in an apparatus provided with two such Nicols. If a plate of quartz or rock crystal, formed by a section at right angles to the principal axis of the crystal, be inserted between the two Nicols, it appears, if observed through the analyzing Nicol, to be brilliantly colored, and the tints change with the rotation of the analyzer; but in no position of the circuit appears the crystal either quite pale or completely dark, and we further notice that the different shades follow each other in the order of the prismatic colors. Repeated experiments with different rock crystals show also that for some of them a right-handed rotation of the analyzer, *i.e.*, in the direction of the motion of the handles on the clock face, produces the change from red to yellow, from yellow to green, from green to blue, and from blue to violet, while for others the opposite motion is required. The one class is said to possess a right-handed polarization, and the other to be left-handed.

To be enabled to understand this interesting experiment let us make use of monochromatic light instead of the white light. The simplest mode to do this is to look through a colored glass of a tint as much as possible homogeneous on the analyzing Nicol.

What appears now in the apparatus is as simple again as before interposing the quartz. Suppose we look through a yellow glass—the light appears again in its maximum of intensity at two points differing from each other by 180°, and at two other positions, differing from the former by 90°, the apparatus is quite dark. But the first bright position is no longer at zero, it is now at 24°, and therefore the other bright point at 24+180=204°. The corresponding dark points are, of course, at 24+90=114, and at 114+180=294°

A most important item is the thickness of the quartz plate, and for one millimeter thickness of the rock crystal the following maxima have been observed:

For Red, 19°	Green, 28°	Violet, 41°
Orange, 21°	Blue, 32°	
Yellow, 24°	Indigo, 36°	

It must also be pointed out that the angle of rotation increases in a direct ratio with the thickness, *i. e.*, in a plate of two millimeters, the maximum for yellow light is at 2× 24=48°.

It will now be clear why, on using the white or complex light, the quartz appears in each position of the analyzer to be more or less colored, and further, that the observed tints are not pure prismatic colors but mixtures of them, the shade of which depends on the kind of prismatic color which predominates or is in its intensity at the special point of rotation. Complete darkness and extinction of colors can never happen, because even if some of the prismatic colors be in the minimum of intensity, the others are still more or less intact. Yet if the quartz plate be very thin, *e. g.*, only ¼ millimeter, then the maximum of intensity for all the single rays which are contained in the white light are lying very near each other, that is, no color really predominates, and the plate appears almost white. In a similar manner is the brilliancy of the picture influenced if the plate be very thick. Phenomena of this kind constitute what is called "circular polarization," and while there are only a few solid bodies known (calcpsar, chlorate of potash crystals, cinnabar) possessing this wonderful property, it was discovered by the French philosopher Biot that many organic fluids act in the same fashion, only in a smaller degree, *e. g.*, a layer of 68 mm. of turpentine rotates the light not more than a rock crystal of only one mm. thickness.

A right-handed polarization shows, for example, a solution of cane sugar, maltose, dextrose, dextrin, soluble starch, camphor in alcohol, etc.

Left-handed rotate: uncrystallizable sugar, gum, albumen, oil of turpentine, etc.

In all these solutions the amount of rotation increases in a direct ratio with the concentration of the solution and with the length of the column through which the light passes. In order to determine the amount of polarization which any liquid exhibits, a solution of it is placed into a glass tube of an exact length (100, 200, or 300 mm as a rule), which is closed with glass slides and screw caps, and then inserted between the two Nicols, which have previously been so ar-

ranged to each other that no light can pass through the instrument. The inserted liquid having a rotatory power, of course, alters the last mentioned circumstances, *i. e.*, light appears now in the apparatus, and either with or without prismatic colors, in accordance with the nature of the light (monochromatic or white) which is allowed to enter the instrument. To produce the same appearance as before interposing the solution, a certain amount of a reversed rotation is now necessary, and this indicates the rotatory power of the liquid in the instrument. There exists a number of different apparatus or polariscopes, according to the special requirements of different observations.

Those constructed for the use of the sugar manufacturer are called "saccharometers," and in the now following lines I will describe first such instruments and then others of a more recent construction, and which are specially adaptable in brewing.

Fig. I. represents the apparatus used by Biot for his researches into the nature of liquids, having the power to rotate the polarized light. The liquid under examination is contained in the tube, *d*, which lies in the groove, *g*. Such tubes of an exact length (mostly 200 mm.) are constructed of brass or glass, and have to be covered while in the apparatus, so as to prevent access of light from foreign sources. On the one end of the groove is the short tube, *p*, and in it is contained the polarizing Nicol, while on the opposite end of the instrument is the analyzing Nicol in the tube, *a*. The axis of *a*, *d*, and P coincide and allow the light, *l*, which is reflected from the black glass mirror, *m*, to pass through the instrument and to be noticed by the observer at *a*.

The tube, *a*, can be turned round its axis, and the amount of rotation may be read off on a scale fixed on the disk, *c*.

Fig. II. shows the instrument constructed by Mitscherlich for the special purpose of determining the amount of cane or beet-root sugar in commercial products, and it was for many years the only apparatus used in German beet sugar works.

P contains the polarizing Nicol, and A the analyzer, which latter may be rotated round its axis. The source of light is an oil lamp or a common gas burner. The zero of the index, J, coincides with the one on the scale, when the minimum of intensity of the light which passes the instrument is observed. The field of sight has then a dark violet color, and the least motion of K makes this tint change into blue and red, hence its name "teinte de passage." If now the brass tube, T, filled with a sugar solution, be inserted, a change of color takes place, each half of the disk appears in a different color, but on carefully moving K the original tint can be restored.

This amount of deviation is indicated by J on the disk, and it is, as stated above, in a direct proportion to the concentration and the column length of the inserted solution. Mitscherlich found by carefully conducted experiments that in his instrument a 200 mm. long column of an aqueous cane sugar solution, containing 30 grammes in 100 c.c., rotates the polarized light for 40 angular degrees if the appearance of the "teinte de passage" is looked to; hence each degree on the disk indicates 0·75 gramme of cane sugar, or, as it is technically called, "crystallizable sugar."

(To be continued.)

TESTING TEA FOR ADULTERATIONS.*

By A. W. BLYTH, M.R.C.S., F.C.S.

THE time is probably not far distant when the tea trade will buy entirely by analysis, supplemented in a few cases by a "taster's" report. An experienced palate will detect particular flavors which analysis may fail to show; but a fairly complete chemical examination of tea is of the highest value, whether as a guide to the purchaser, or merely to show its freedom from adulteration.

(1.) *Preliminary Examination of Tea.*—The tea leaves should be soaked in hot water, carefully unrolled, and their shape and structure examined. Sections can be made of leaves by placing them between two pieces of cork and cutting fine slices of both the cork and the inclosed leaf; on floating the sections in water, the film of cork may be readily separated from the leaf. The epidermis of the lower and upper surfaces can, with a little practice, be detached in small portions by the aid of a sharp razor, and examined in water, glycerine, or dammar balsam, under the microscope.† The structure of the tea leaf has been already noted. The following is a brief description of the principal leaves supposed to be used as adulterants:

Beech (*Fagus sylvatica*).—The leaves of the beech are ovate, glabrous, obscurely dentate, ciliate at the edges, the veins running parallel to one another right to the edge. The leaf, slightly magnified, is seen to be divided into quadrilateral spaces by a network of transparent cells. On section, the parenchyma of the leaf is found to consist of an upper layer of longitudinal cells, and a lower of loose cellular tissue, inclosed between the epidermis of the upper and under surface. The whole section is thus divided into oblong spaces by transparent cells connecting the cuticle of the upper and lower surfaces. The epidermis of both the upper and lower surfaces is composed of cells with an extremely sinuous outline. The stomata are small, not numerous, and almost round; average length, 0·000996 inch; average breadth, 0·00083 inch. Beech leaves contain manganese.

Hawthorn (*Cratægus oxyacantha*).—At least two varieties, the more common of which is the *C. monogyna*, with obovate three to four deeply-lobed leaves, with the lobes acute. The leaf is divided into quadrilateral spaces, like the beech and many other leaves, by a transparent network. The epidermis of the upper surface is composed of a layer of thin-walled cells, generally quadrilateral, outline seldom sinuous. The epidermis of the lower surface has a layer of thin-walled cells, with a very sinuous outline. Stomata large, distinct, and numerous, and in many instances nearly round, but the shape mostly oval. The average length of the stomata is 0·00166 inch, the average breadth 0·00149 to 0·0015 inch.

Camellia Sassanqua.—The leaves of *Camellia sassanqua* are oval, obscurely serrate (the younger leaves entire), dark green, glabrous, of somewhat leathery consistence; the lateral veins of the leaf are inconspicuous.

Micro-structure.—The parenchyma of the leaf is placed between two thickened epidermal layers: the epidermis of the upper surface, as seen upon a section, forms a wrinkled, continuous, thick membrane, in which a cellular structure is not very evident. Below this there are two or three layers of large cells, more or less oblong, with their long diameter at right angles to the surface of the leaf; and underneath this again is a loose network of cells, resting upon an epidermis in every respect similar to that of the upper surface, but only half as thick. A thin layer of either the upper or lower epidermis shows a peculiar dotted or reticulated appearance, not unlike the rugæ of a stomach. The lower epidermis is studded with frequent stomata, which are of an oblong shape, length 0·001328 inch, breadth 0·00083 inch.

Sloe (*Prunus communis*).—The leaves of the common sloe are rather small, elliptic or ovate-lanceolate in shape, and slightly downy beneath. The sectional thickness of the leaf is the same as that of tea, viz. 0·00664 inch. The stomata on the lower surface are scanty, in length about 0·00166 inch; in breadth, 0·00083 inch. The microscopical appearances are wholly different from those of tea leaves, more especially as seen in section.

Chloranthus Inconspicuus.—The leaves of the *Chloranthus inconspicuus* are long, oval, serrate, wrinkled, the veins running nearly to the edge, and there forming a network in such a manner, that at the point of intersection little knots are formed, which give the margin of the leaf a very rough feeling. The structure of the leaf is very simple. The epidermis of the upper surface is formed of one or two layers of thin-walled cells, the epidermis of the lower of one or two layers also of cells, and between the two there is a parenchyma of loose cellular tissue. The stomata are oval and rather numerous; their length is from 0·001992 to 0·002188 inch, their breadth 0·001338 inch. The cells of the epidermis are large, some of them 0·005 inch or more in their long diameter.*

The dimensions of the stomata of the various leaves just described may be conveniently arranged in a tabular form, thus:

	Length of Stomata. Inch.		Breadth of Stomata. Inch.
Beech	0·000996		0·00083
Camellia sassanqua	0·001328		0·00083
Tea from 0·001162 to	0·001328	from 0·000996 to	0·001162
Sloe	0·00166		0·00083
Hawthorn	0·00166		0·00149
Chloranthus inconspicuus	0·001992		0·001328

A chemical method for the detection of foreign leaves (adulterants) was first described by the writer in June, 1877.† It is based upon two facts, first: that every part of a theine-producing plant—wood, stem, leaf, flowers, and even hairs, contains the alkaloid; and secondly, that this can be readily sublimed. The leaf, or fragment of a leaf, is boiled for a minute in a watch-glass with a very little water, a portion of burnt magnesia equal in bulk is added, and the whole heated to boiling, and rapidly evaporated down to a large-sized drop. This drop is transferred to the "subliming cell," described in another portion of this work (*see Index*), and if no crystalline sublimate be obtained, when heated up to 110° C. (a temperature far above the subliming point of theine), the fragment cannot be that of a tea plant. On the other hand, if a sublimate of theine be obtained, it is not conclusive evidence of the presence of a tea leaf, since other plants of the camellia tribe contain the alkaloid.

Finally, there is a negative test which may occasionally be valuable. All fragments of tea hitherto examined contain manganese, and there are a few foreign leaves in which manganese is constantly absent. Hence, if a leaf be burnt to an ash, and a fragment of the ash be taken up on a soda-bead, to which a little potassic nitrate has been added, the absence of the green manganate of soda would be sufficient evidence that the leaf had not been derived from the tea-plant, while conversely, as in the case of theine, it does not in itself prove it to be tea.

Another portion of the tea leaves should be thoroughly bruised, spread on a glass plate, and carefully searched with a magnet for ferruginous particles—the so-called iron filings, which are occasionally found, especially in capers and certain species of congou. It is almost unnecessary to state that the black, irregular masses found in tea, and attracted by a magnet, are not metallic iron.‡ Their chemical composition is somewhat variable; they all contain magnetic oxide of iron, and many of them in addition phosphate of iron, titanate of iron, quartz, and mica with a little sand. They are, without doubt, sometimes an adulteration (the author has himself found over 1 per cent.), and sometimes an impurity, for in a few teas mere traces only of this ferruginous sand may be discovered. Any particles of the kind extracted by the magnet should be collected and treated with hot water, which soon disintegrates them; the adherent tea-dust is separated, and the sand dried and weighed.

To detect facing, the tea in its dried state should be mounted as an opaque object. If it has the appearance of being heavily faced, soaking in warm water will soon detach the film; and indigo, Prussian blue, or similar substances will sink to the bottom, and may be collected and examined. Indigo may be identified by the microscope. Prussian blue may be tested for by warming the deposit with caustic alkali, filtering, acidifying the filtrate with hydrochloric acid, filtering again if necessary, and testing the filtrate with ferric chloride. The residue left after treatment with caustic alkali may be tested for magnesium silicate, by first extracting with HCl, and then collecting the insoluble residue, and fusing it with an alkaline carbonate. The silica is now separated in the usual way by evaporation with HCl to dryness, subsequent solution in weak acid, and filtration; any lime is removed by ammonia and ammonia oxalate; and lastly, magnesia is precipitated as ammon. mag. phosphate. Magnesia found under these circumstances must have been present as steatite or other magnesian silicate.

(2.) *Chemical Analysis.*—The preliminary examination of the tea having been concluded, the sample is next submitted to chemical analysis. If the question to be decided is simply that of adulteration, the taste of the infusion, the percentage of extract, and a determination of the chief constituents of the ash, are in most cases all that is necessary; but a more or less complete examination embraces a quantitative estimation of hygroscopic moisture, theine, total nitrogen, tannin, extract, gum, and ash.

Hygroscopic Moisture.—The ordinary method of taking the hygroscopic moisture of tea is to powder as finely as possible an indeterminate quantity of from 1 to 2 grms., and to heat it in a watch-glass over the water-bath until it ceases to lose weight. It should be finally weighed between two watch-glasses, since it rapidly absorbs moisture from the air.

The method given is in its results incorrect, since some volatile oil and a small portion of theine are always volatilized. That theine is actually lost is capable of rigid demonstration; it is only necessary to heat a few leaves of tea between two watch-glasses over the water bath, and theine crystals can be readily discovered by the microscope. To devise a process of drying tea which will represent water only is easy; but since the loss both of volatile principles and theine does not materially affect the results, it is scarcely worth while to complicate the analysis by the use either of a lower temperature or of processes of absorption. The highest amounts of moisture in a genuine tea which are on record are two specimens from Cachar, analyzed by Professor Hodges—the one (indigenous) gave 16·06 per cent., the other, a hybrid, 16·2 per cent. These were, however, not commercial teas, and appear to have been simply dried in heated rooms. The average hygroscopic moisture found by Mr. Wigner in thirty-five teas, consisting of hysons, capers, souchongs, gunpowders, and others, was 7·67 per cent., the driest teas being the hysons and gunpowders, the moistest the congous:

				per cent.
The maximum	amount of moisture	found in	hyson,	5·68
The minimum	"	"	"	4·84
The maximum	"	"	gunpowder,	6·55
The minimum	"	"	"	4·94
The maximum	"	"	congou,	10·38
The minimum	"	"	"	6·36

* From the *Indian Tea Gazette.*

† There are various section machines in use, but after trying several I have forsaken all save in cases of soft pulpy tissues, etc., where it is convenient to freeze the substance. With a very little practice, sufficient manual dexterity to obtain a fine section is acquired with the fingers alone. The whole of the beautiful preparations whence Schleiden obtained the illustrations for his botanical works were taken by the aid simply of a sharp razor.

* The leaves of *Epilobium angustifolium* (*common willow herb*) are said to be extensively used in Russia for the adulteration of tea. The dried leaves are sold for from four to six rubles a pound, and are used by the poorer classes in the place of tea. Alcohol produces in infusions of epilobium a precipitate of mucilage.—*Pharm. Zeitsch. fur Russland*, *Year Book of Pharmacy.*

† "Micro-Chemistry, as applied to the Identification of Tea Leaves." By A. Wynter Blyth. *Analyst*, June, 1871.

‡ Mr. Allen appears to have found metallic iron in tea. The test for metallic iron is that nitric acid, 1·2 specific gravity, dissolves it with the production of red fumes; it also precipitates metallic copper if added to an acidulated solution of cupric sulphate.

[Continued from SUPPLEMENT, No. 200.]

THE SOUTH PASS JETTIES.

NOTES ON THE CONSOLIDATION AND DURABILITY OF THE WORKS, WITH A DESCRIPTION OF THE CONCRETE BLOCKS AND OTHER CONSTRUCTIONS OF THE LAST YEAR.

By MAX E. SCHMIDT, C.E.

III.

Recent Constructions at the end of the Jetties.

THE mode of constructing and depositing the concrete at the South Pass Jetties is novel in many respects, and, with the aim of contributing facts that may be of value, for the information and study of those interested in such matters, I have prepared the following notes on the two most important parts, now under construction at the sea ends, namely, the concrete work and the slope at the sea end.

1.—CONCRETE WORK.

(*A.*) *Preparatory Work, Machinery, and Implements.*

Both jetties have been treated in the same manner, both having received an independent and similar share of the preparatory and auxiliary work.

The plan on Plate V. represents the immediate surroundings of the concrete mixer on the East Jetty, ten thousand two hundred feet below the eastern land's end.

On account of the shoalness of the water near the jetty, and, in order to facilitate the transportation of the material from the barges to the storage wharf, the latter has been connected by a bridge-portion sixty-three feet long, with the deeper water in the channel.

The storage wharf, bridge-portion, and wharf-head are founded upon four hundred piles, driven at intervals of eight feet, and connected with a 5x14 inch cap, for the support of the flooring.

The cement house occupies the northeastern portion of the storage platform. It is a low building, nearly square, and without windows. The roof is covered with felting, a layer of liquid pitch, and fine sea shells. The climate is damp, and these precautions were necessary for the preservation of the cement.

All the other ingredients, namely, sand, gravel, and broken stone, are piled loose at different places on the platform, ready for immediate use.

The mixer or mill is placed over the jetty proper, and consists of a 5 foot 9 inch cube, made of quarter-inch boiler iron, well riveted and held together by bands of flat and T iron.

This cubical box is suspended by two hollow cast-iron trunnions, seven and one-half inches in diameter, which are riveted from the inside of the box to two diagonal corners opposite each other, and rest in a tower or framework substantially built of heavy timber. The center of the trunnion is twenty-two feet above average flood tide, and the mixer is revolved by a steam engine which stands on the wharf below.

The two views on Plates VI. and VII., together with the plan on Plate V., will materially aid in understanding this partly novel machinery.

It will be seen that the cubical box has been cut off horizontally on one of the corners, so as to obtain a triangular opening for admitting and discharging the material. A cover (D, Plates VI. and VII.) is made of the severed portion, and a small hand crane is provided by which it can be lifted and shifted.

As the mixer has to be opened and shut once for each charge of concrete it is a matter of consequence to have the manipulation proceed as rapidly as possible. The method employed has worked satisfactorily.

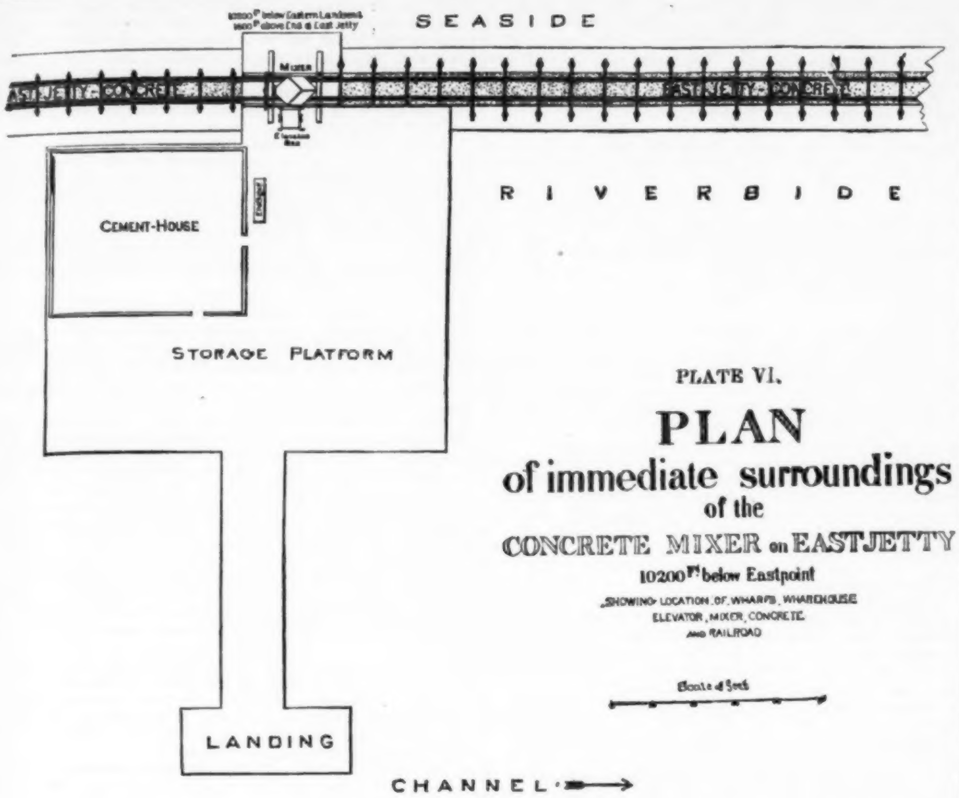
When the mixer is filled it is closed by sliding the cover under the four clasps or lips, which may be seen on the drawing, and at once secured by four point screws. The hinged screws, *s s*, are then righted up and screwed with their nuts down.

To allow the rapid working of these six screws long handles have been attached to their upper ends.

The water enters the box through the hollow journal at B B while the ingredients are being revolved. The tank, C, which supplies the water stands on the top platform, and has a floating gauge attached to it which is watched by the man whose duty it is to shut the valve, A, when the requisite quantity of water is admitted. The engine in its turn fills the tank.

For the transportation of the dry material from the wharf to the opening in the mixer, and the lift of nearly forty feet in height necessarily included in the operation a steam elevator forty-two feet high has been erected on the river side, and close to the mixer.

Hand carts, constructed for this purpose, as an improvement on wheel-barrows, are used for conveying the ingredients to the elevator box, E E, where they are deposited in



different layers alternately. The elevator box is of wood, lined with sheet iron, measuring 6¼x5¼x4 feet, with sloping bottom, and trap door facing toward the mixer. It is guided by cleats, which project between the vertical leaders, F F, and ascends until the bottom reaches the trough, H H, when the trap door is opened and the contents turned into the mixing cube. The trough, which guides the material, is also lined with sheet iron, and is kept covered.

The revolutions of the mixer to each charge number twenty-two; the time required is about two minutes and twenty seconds, which is sufficient to thoroughly incorporate the ingredients.

From the drawings it will be seen that a railroad track has been laid to facilitate the quick deposit of the concrete. This track follows the center line of each jetty, and extends up and down stream from the mixer station sixteen hundred feet seaward and twenty-two hundred feet landward. A branch track on the seaside has also been built for a distance of three hundred feet, at the extreme sea end, to aid in the construction of the sea slope.

The top of the rail at the mixer is ten feet above average flood tide, and at the sea end it is seven and one-half feet above that plane, the descending grade being chosen to be of advantage when the cars leave the mixer with a load of concrete.

The bents are eight feet apart, each composed of two cypress piles of sixteen inches diameter at the butt end, driven through the cone of the jetty. A 5x14 inch cap is set on edge and drift-bolted to the piles, and 6x8 inch stringers are laid in the line of the track for the support of the rail.

The piles in each bent are driven as close together as the width of the concrete block designated for the place permits. A few feet are generally added to allow for the placing of the moulds. Toward the sea end the bents have been well stiffened by diagonal braces and bearings.

The track above the mixer station is mounted on trestle work, the bents being 8 feet apart, as in the case where piles are used.

The "rolling stock" of this railroad consists, for each jetty, of one locomotive and one concrete dumping car (see illustrations, Plates VI. and VII.). The locomotive is set upon a truck, which was originally intended to be used for a second concrete car when it was expected to run the cars by hand.

But, under the necessity of more rapid means of conveyance, the demand for a locomotive became soon apparent. The one illustrated is constructed almost entirely of old scraps, such as will collect in the shops of large works. It is propelled by an ordinary rotary engine, and has been extremely useful.

The cars used for the dumping of the concrete were made by the same firm who contracted for the mixers (Pusey, Jones & Co., of Wilmington, Del.). They are 6½ feet long, 4 feet wide, and 3 feet 3 inches deep, and made to contain about two cubic yards. They are strongly built, of quarter-inch boiler iron, and mounted 9 inches below their center of gravity, on an iron axle 3 inches in diameter, which is riveted by a round plate to both ends of the car. With the help of two ratchet wheels and wooden levers permanently attached to the axle on each end of the car, the dumping of nearly 9,000 pounds of concrete is done almost automatically, and the car is easily turned back to its upright position by two men (see Plate VI.).

Special attention might be called to additional details of interest, but their discussion would occupy too much space. The drawings on Plates VI. and VII. show the mechanism of the work so as to be easily understood.

(*B.*) *Method of Placing the Concrete.*

The operations involved in this method are as follows:

1. The preparing of a level bed.
2. The placing of the moulds.
3. The conveying and discharging of the concrete.
4. The removal of the moulds and the protection of the sides by stone.

A level and solid bed is one of the chief requirements for the successful formation of the concrete blocks.

A gang of men is detailed for this purpose, and equipped with shovels, picks, and crowbars. They commence by first removing the larger rock from the top of the jetty, and throwing it over on the river or sea side, wherever it seems to be of most advantage.

Small flats with gravel and broken stone are then moored alongside, and the contents wheeled or thrown with shovels on the embankment, there to be distributed and leveled. Pains are taken to thoroughly incorporate the gravel and small stones with the willows of the old mattresses. The foreman is provided with a gauge staff, by which he is enabled, referring to the railroad track, to bring the surface of the jetty to a uniform level.

When the weather is rough, which is by no means a rare occurrence, the material is brought by cars from the storage platform at the mixer station, and dumped wherever it is needed.

The placing of the "moulds" is next in order.

The moulds are wooden boxes, whose inside dimensions

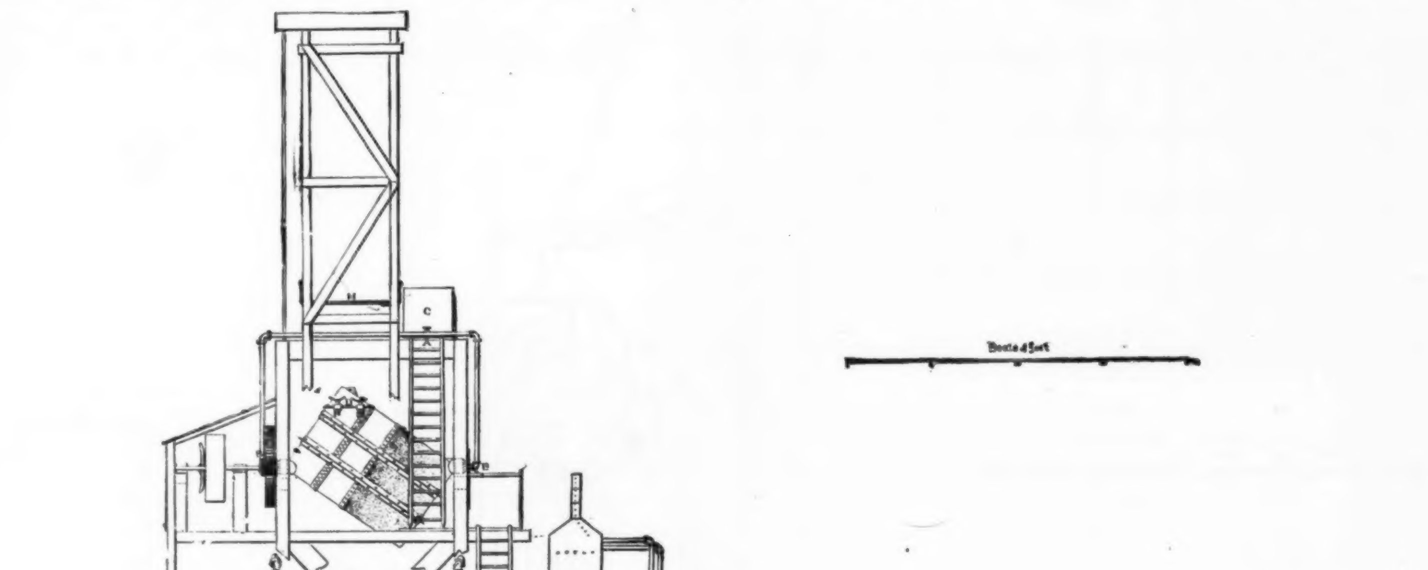


PLATE VI.—CONCRETE MIXER ON EAST JETTY, 10,200 FT. BELOW EASTPOINT.—SIDE ELEVATION LOOKING EAST.

correspond with the size of the blocks. Plate VIII., Figs. 1, 2, 3, show details of a mould for the formation of a block twenty feet long, twelve feet wide, and three and a half feet thick. The moulds are composed of a thin flooring and uprights or stanchions, which are so fixed that they will hold the sidings in place temporarily until the concrete has hardened. To this end, inch boards are spread longitudinally on the jetty where the blocks are already finished. Cross ties or battens, *a, a, a*, of 2x6 inch lumber, are nailed to the flooring at intervals of four feet. Two uprights or stanchions, *b, b*, are then put up in the center of the two end ties, opposite each other, and pieces of two inch plank, *e, e*, twelve feet long, permanently nailed to them and raised to the proper height three and a half feet above the flooring. The twelve stanchions, *d, d*, are set next at right angle to the flooring, twelve feet four inches in the clear, there being always two for each cross tie. These stanchions are held at the lower end by a dovetailed piece of square lumber, *e*, nailed to the ties outside, and facing a corresponding notch on the outer side of each stanchion. The sidings, consisting of two inch planks, twenty feet four inches long, provided in each end with clamp hooks of one inch strap iron, are then set on the inside of the line of stanchions, *d, d*, the hooks clamping the end sidings. (See end elevation, Fig. 2, Plate VIII.).

The top planks, *f, f*, on both ends, being fifteen feet long, are so placed that they project one and a half feet out on each side. They have two notches, *g, g*, nine inches wide and one and a half inches deep, at the upper edge, for the reception of a stiffening plank, *h, h*, with two iron clamp hooks on each end to clasp the siding at the edge. Wedges, *k, k*, are used to hold the plank in position.

These moulds, constructed almost entirely without nails or spikes, are sawed out in parts and fitted by carpenters, and carried on trucks over the finished blocks forward to the place where they are needed. Here the flooring is laid down on the jetty, and the other parts are then quickly put in place.

It will be noticed that all the stanchions are on the outside of the box excepting the two at each end. These are inside, in order to permit the placing of the blocks within a few inches of each other.

As a rule every mould is pushed up close to the finished block above, and its position is verified by referring to the center of the railroad track.

The filling of the mould with concrete may begin immediately after this. The carpenters return with their empty truck, the men who level up the jetty proceed down stream, and the masons take their places in the mould to attend to the concrete as it is being deposited.

The concrete is made in single charges, measuring two cubic yards each. Each charge as soon as deposited in the car under the mixer, is taken without delay to the place where it is to be dumped. The time consumed in the transfer varies, of course, with the distance. But the speed allowed to the engine being about twelve miles per hour, seldom more than one minute of time will be consumed in the run between the stations. The train stops directly over the mould, the two men on the front and rear platform release the pawls which hold the ratchet wheels, and the concrete is dumped into the box.

The total time required for the transportation of the material contained in one charge, from the different depots to the moulds on the jetty, has been ascertained to be as follows:

	Min.	Sec.
1. From wharf to elevator box....	7	55
2. From elevator box to mixer..........	3	43
3. From mixer to car....................	4	27
4. From station to station..	1	00
5. From car into moulds................		30
Total	17	35

The hand labor is so regulated as very nearly to balance the functions of the engine, and, in this manner, only fifty per cent. of the time required is really consumed, so that about nine minutes are required to make and place two cubic yards of concrete, or one hundred and twenty-three cubic yards in one day of ten working hours.

It should not be inferred, however, that this is an average of the daily work done. There are days when rapid progress will be unavoidably delayed by rough weather, or during extreme high water at spring tides. In such cases, the placing of the mould boxes is seriously impeded, and, in consequence, the mixer cannot be worked to as great advantage. One hundred cubic yards of concrete is a fair daily average on one jetty.

During the earlier part of construction the concrete was rammed by masons in the moulds. But of late this process has been entirely abandoned, as it has been found that the vertical fall of from ten to twelve feet, from the car into the mould, leaves the particles in a far better state of compression than could be obtained through ramming.

The concrete, after being deposited, is stirred as little as possible and only shifted while it is quite fresh, to fill up irregularities and keep the layers approximately level and parallel.

When the top of the mould is reached the surface of the concrete is roughly leveled with a rake, and allowed to set without further disturbance. Another mould is then commenced, filled, and so on, one after another, according to the plans.

Four days after the setting has commenced, each block is coated on the surface with a plastering of mortar, composed of fifty per cent. by volume of American Portland cement and fifty per cent. of sand. The depth at which this mortar is laid may vary from one to three inches. It is applied with the trowel, and all joints between the stones and other irregularities that may exist on the surface and near the edge of the mould are well filled and smoothed off. The mortar is prepared in small quantities, and the plastering done quickly. The box is finally covered with inch boards and not disturbed again for two weeks. During that time the sea and river side of the blocks are protected by a revetment of rubble stone.

At the end of two weeks the concrete has become fully hard enough to allow the removal of the moulds. The wedges, *k, k*, Plate VIII., Fig. 1, are then pulled out, the stiffening planks, *h, h*, removed, and the stanchions, *d, d*, and longitudinal sidings taken away.

The stanchions, *b* and sidings, *e*, which rest close between two blocks, are left until some future day, when they may be removed, and the small interval filled out with mortar or rubble masonry.

(*C.*) *Notes on Ingredients composing the Concrete.*

The concrete is made of broken stone, gravel, sand, and cement. The broken or macadam stone is quite irregular in shape, being broken by hand. The size is specified in the contract, each of the stones is to pass through a ring, three inches in diameter.

The gravel is brought from Prophet's Island, near Baton Rouge, La., a distance of two hundred and fifty miles above the jetties. It is obtained from the deposits at the mouth of a creek which empties into the Mississippi, and is raised from the bottom by dredging. The pebbles vary in size from one-thirtieth of an inch to two and a half inches in diameter. The sand is delivered by schooners, and comes from the islands in the Mississippi Sound, near the mouth of Pearl River, Miss. It is a moderately coarse and sharp-grained sand, of white or pale yellowish color, the diameter of grains averaging about one-fortieth of an inch. It is dug up in a state of humidity, from a depth of several feet below the surface, and used as fast as it can be delivered at the works.

It may be stated that the quality of the sand which is found in the more direct neighborhood of the delta, and on the reefs adjacent to the jetties, is not deemed suitable for the purpose of concrete making, as it is chiefly composed of fine and round particles of silicious nature, rarely exceeding one-seventieth of an inch in diameter.

In the table below may be found the percentage by volume of voids, and the weight per cubic foot of the stone, gravel, and sand used in the concrete.

MATERIAL.	Percentage by volume of voids.	Weight per cubic foot.
Broken stone................	0·489	79·50 lb.
Clean gravel.................	0·314	119 24 "
Sand........................	0·333	79·72 "

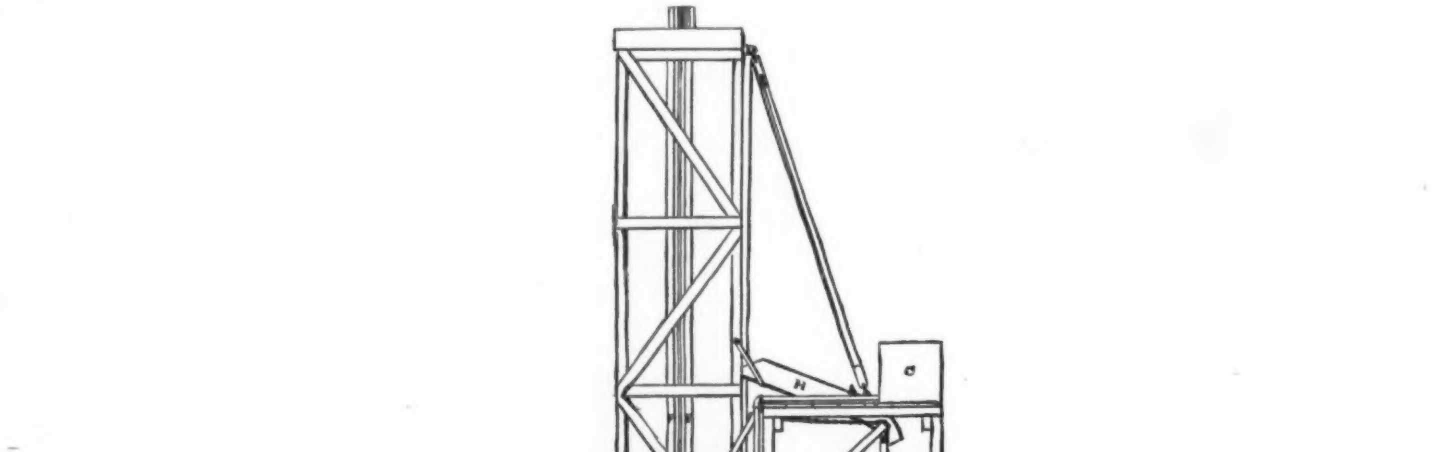


PLATE VII.—CONCRETE MIXER ON EAST JETTY.—END ELEVATION, LOOKING NORTH.

The cement which is employed at these works is Saylors' American Portland cement, over five thousand barrels of which have been used to date. Careful tests which have been made with it have justified Mr. Eads in further recommending its use. The following table, condensed from numerous daily tests, and grouped to save space, in the order of months, exhibits the results obtained from the tests of this cement. The testing is done on fineness, weight, and tensile strength, in conformity with the specifications of the contract, and in a careful manner.

For testing of tensile strength, a Riehle counterbalance testing machine is employed. The briquettes represent an area of two and a quarter square inches in the section, but they are sufficiently enlarged on both ends, for the application of the clamps.

CONDENSED TABLE OF CEMENT TESTS.—S. P. JETTIES.

MONTH—1879.	Number of tests from which average is tak'n.	Seven day test, average tensile strength in lbs. per sq. inch of neat cement.	Percentage passing sieve, 2,500 meshes to sq. inch.	Weight per U. S. struck bushel in pounds.
February.....	155	285 lb.	84	117·60
March........	157	262 lb.	87½	123·00
April.....	271	288 lb.	84½	121·00
Aver'ge result.	583	278·3 lb.	85·3	120·53 lb.

The cement is shipped from New York by steamer to New Orleans, and thence on barges to the storehouses at the jetties.

Considering the damage to cement, which often results from transhipment by sea, the tests of three months at the jetties are all the more satisfactory.

Saylors' Portland cement is a slow-setting cement, which may be moderately restirred and shifted, without destroying its hydraulicity.

The market weight of a barrel of this cement is 380 lb., or 133·33 lb. per cubic foot. When gauged in this state of compactness, with one-third measure of water, the paste will expand, so as to occupy 3·9 per cent. in excess of the volume originally occupied.

When piled loose, so as to weigh eighty-nine and a half pounds per cubic foot, and gauged neat, with enough water to make a paste of similar consistency, the latter will shrink until it occupies 80·7 per cent. of the volume originally occupied.

These deductions were important in deciding upon the proportional parts of ingredients composing the concrete.

Minor points have been changed, but essentially the proportional parts have remained as follows:

15 parts by volume of broken stone.
4·38 parts " " gravel.
8·28 parts " " sand.
3·00 parts " " cement (barrel weight).

It should be stated that the gravel in this estimate is clean gravel, referring only to those particles which are rejected by a sieve having three hundred and twenty-four meshes to the square inch. Thirty-eight per cent. by volume of the gravel delivered at the works will pass through such a sieve.

From this, and with the coefficients of voids, the net contents of one hundred cubic feet of set concrete may be computed as follows:

1. Broken stone, 80·75 cub. yds., which gave 41·26 cub. yds. of solids.
2. Clean gravel, 23·58 " " 16·17 " "
3. Sand, 44·57 " " 29·73 " "
4. Cement, 16·15 plus expans'n " 16·78 " "

Dry material, 165·05 cub. yds., make 103·94 c. yds. of concrete.

From this the coefficient of shrinkage may be obtained.

$$S = \frac{103 \cdot 94}{165 \cdot 05} = 0 \cdot 629.$$

The excess of 3·94 cubic yards is consumed in the final induration of the concrete. The figures have been computed from careful observations, and may be relied upon.

The ingredients are mixed with fresh water, in quantity equal to about ten and a half per cent. of the volume of the dry material. The amount is registered on the gauge.

(*D.*) *Present Condition of Work and Observations on Concrete Blocks.*

TABULAR STATEMENT SHOWING PRESENT CONDITION OF CONCRETE WORK, SOUTH PASS JETTIES.

	EAST JETTY.	WEST JETTY.
Total length of concrete in lineal feet, proposed to be laid.......	3,800 feet.	2,800 feet.
In place June 11th, 1879	2,097 "	2,324 "
Balance remaining, in lineal ft.	1,703 "	476 "
Total amount of concrete, in cub. yds., proposed to be laid, including parapet	3,735 c. yds.	3,087 c. yds.
In place June 11th, 1879.........	2,071 "	1,899 "
Balance remaining in cub. yds.	1,664 "	1,188 "

By far the greater and most difficult part of the concrete work is already in place. On the East Jetty the lowest block is within one hundred and sixty-seven feet of the extreme sea end, and on the West Jetty the blocks have approached the end to within four hundred and seventy-six feet.

Operations are now chiefly confined to the upper end, where the smaller width of the blocks allows the work to proceed at the rate of one hundred and twenty lineal feet daily.

The weight of the concrete has been ascertained by actual test, and by computing the weight from the different dry ingredients, as follows:

Concrete green .... 160 lb. per cubic foot.
" thoroughly dry.... 149 lb. " "

The blocks, after removing the moulds, expose, generally, a uniform and smooth surface. Irregular places and holes are plastered by the masons.

In regard to the construction of the parapet, it has not been decided yet when it will be time to commence. The degree of subsidence displayed by the blocks will settle this point in course of time.

At present it may be too early, from the limited amount of observations, to discuss the probabilities involved in this question. It is clear, however, that the amount of compression exerted by the tremendous weight of the blocks will continue to act upon the elasticity of the subaqueous layers of mattresses, until the same is ultimately destroyed.

A complete record, ascertained by careful and frequent periodical levelings, is kept of each block, and the elevations are compared with the original plane at which the blocks were set.

There seems to be a general tendency on the part of the blocks to settle within the first ten days of their construction, and then to remain stationary or nearly so for an indefinite period.

The impetus imparted by the sudden application of so great a weight is evidently the cause of this action.

The subjoined tables are given to further illustrate this subject.

TABLE 1

SHOWING SUBSIDENCE OF CONCRETE BLOCKS, AT DIFFERENT PERIODS, ON EAST JETTY.

Number of contiguous Blocks from which average is taken.	Net weight of mass of Concrete under consideration in tons of 2,000 lb.	Initial elevati'n of top of blocks above av'ge flood tide.	Date when placed.	Date when levels were taken.	Elevation above A. F. Tide at those dates.	Elevation above A. F. Tide on June 11th.
	Tons.	Feet.			Feet.	Feet.
4	110	3·00	Feb. 2.	Feb. 10.	2·685	2·480
4	136	3·00	" 12.	" 20.	2·440	2·140
4	136	3·00	" 18.	" 20.	2·790	2·000
4	150	3·00	" 24.	Mar. 4.	2·605	2·415
4	150	3·00	Mar. 4.	" 14.	2·610	2·406
4	193	3·50	" 8.	" 14.	3·351	3·150
4	193	3·50	" 11.	" 25.	3·440	3·328
4	288	3·75	" 15.	" 25.	3·533	3·373

FIG. 1.

MOULD BOX FOR CONCRETE BLOCKS

TOP VIEW

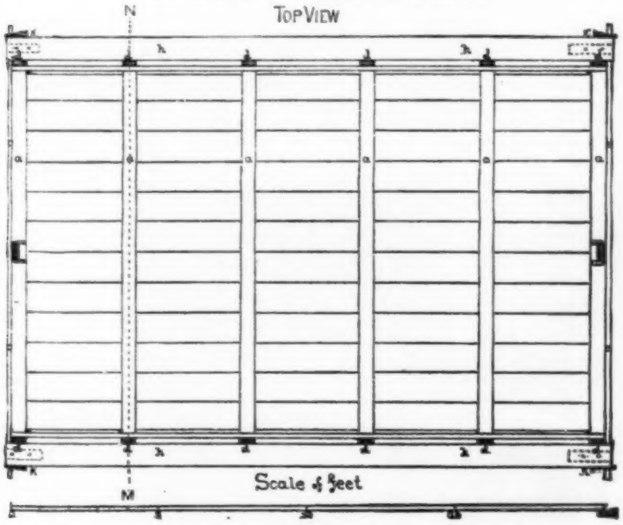


FIG. 4.

PALMETTO-CRIB-WORK

TOP VIEW

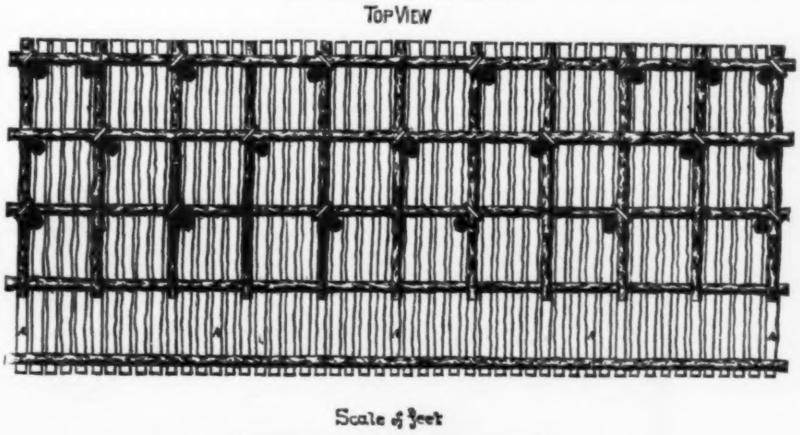


FIG. 2.

MOULD BOX FOR CONCRETE BLOCKS

END ELEVATION

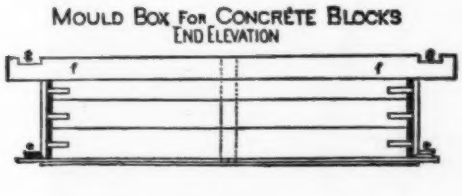


FIG. 5.

PALMETTO-CRIB-WORK

END ELEVATION, SHOWING POSITION ON WAYS

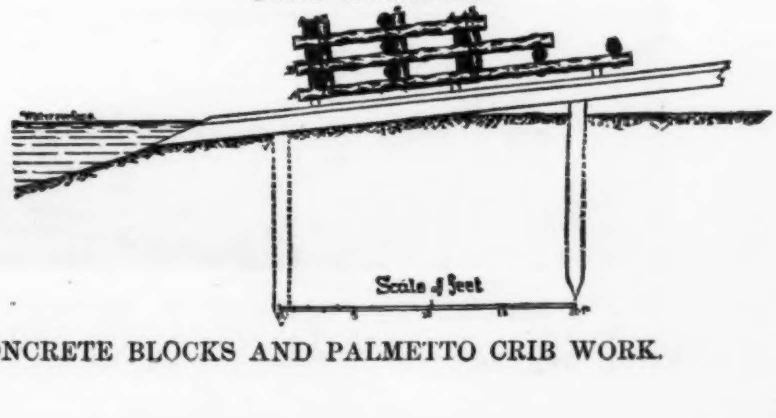


FIG. 3.

MOULD BOX FOR CONCRETE BLOCKS

SECTION ON M-N

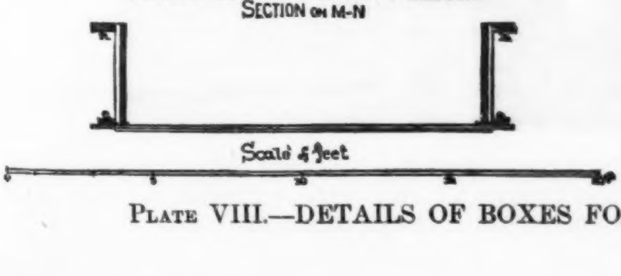


PLATE VIII.—DETAILS OF BOXES FOR CONCRETE BLOCKS AND PALMETTO CRIB WORK.

TABLE 2.

SHOWING SUBSIDENCE OF CONCRETE BLOCKS, AT DIFFERENT PERIODS, ON WEST JETTY.

Number of contiguous Blocks from which average is taken.	Net weight of mass of Concrete under consideration, in tons of 2,000 lb.	Initial elevati'n of top of blocks above av'ge flood tide.	Date when placed.	Date when levels were taken.	Elevation above A. F. Tide at those dates.	Elevation above A. F. Tide on June 11th.
	Tons.	Feet.			Feet.	Feet.
4	110	3·00	Mar. 21.	Mar. 24.	2·912	2·854
4	110	3·00	" 24.	Apr. 7.	2·930	2·785
4	136	3·50	" 27.	" 7.	3·262	3·131
4	136	3·50	" 29.	" 7.	3·200	2·981
4	136	3·50	Apr. 1.	" 7.	3·410	3·041
4	150	3·50	" 6.	" 18.	3·420	3·343
4	150	3·50	" 8.	" 18.	3·130	3·083

2.—SLOPES AT THE SEA END.

The construction of the sea and river slope by palmetto crib work, as proposed for the lowest six hundred feet of the jetties, was not commenced before the month of April of the present year. Plate VIII., Figs. 4 and 5, represent a sloping crib, fifty feet long, twenty-two feet wide, and five and a half feet high, intended for shoal water.

Before the dimensions of a crib are given to the carpenters, a careful investigation is made, embracing depth of water and condition of bottom, on and near the place where the crib is to be placed. Referring to the one on the drawing, there are fifty-one palmetto piles (A, A, see Figs. 4 and 5), each twenty-two feet long, which are placed in one row, one foot from center to center, on the inclined ways, formerly used for mattress building.

Tish being the floor of the crib, a second row, consisting of five logs, B, is placed to break joints with the flooring, at distances of five feet, from center to center. In the same manner the third row is placed, consisting of eleven piles, sixteen and a half feet long, at distances of five feet between the centers, and breaking joints with the lower row.

Auger holes are then bored, and the rows bolted to each other by one inch bolts. The fourth and fifth row of piles is then laid, as shown on the illustration, and drift-bolted to the lower layers.

The crib is braced by short logs, C, C, standing upright against the corners of a cell. Their lower ends are flattened, and wedged tight between the flooring, where they are fastened by bolts.

In addition to this, stirrup bolts are used at every alternate corner of a compartment, which tie all the logs from the bottom to the top.

The compartments are four feet square in the clear, and large enough to admit the largest bowlders that are brought to the jetties.

The cribs are pulled off the ways and into the river by a tug, which takes them at once to the place for which they are built.

Here a row of guide piles has been driven, about ten feet from the jetty embankment, to which the vertical edge of the crib is lashed. The sinking may then take place. The compartments are finally closed by immense bowlders, which are lifted into position by a derrick.

The remaining space of about ten feet in width, between the vertical edge of the crib and the jetty embankment, is filled with stone until it appears above water.

At some of the cribs the flooring has been constructed of palmetto logs, split lengthwise through the center, but it is quite immaterial to the strength of the crib; besides the labor involved in cleaving the logs, hardly justifying its constant application, it was only resorted to when the supplies ran short.

NOTE.—Since the presentation of the above paper at the convention at Cleveland, the following official information has been secured, and is added to complete the record:

1. On June 18, 1879, a channel of 26 feet in depth, and at no point less than 200 feet wide, was obtained through the jetties.

2. On July 8, 1879, a channel of 30 feet in depth, without regard to width, was obtained through the jetties. (See Plate XII., Bar Survey by United States Engineers.)

3. On July 10, 1879, a navigable channel of 26 feet in depth was obtained at the head of the Pass, connecting the deep water in the Mississippi with the deep water of the South Pass.

Thus, in less than four years from the day on which work was begun, the final result aimed at has been accomplished, and there exists now at the mouth of the Mississippi a channel which will constitute the greatest commercial highway in the world.

[We omit Appendix A. Explanatory Remarks on the Chart of Jetty Channel, and Appendix B, Explanatory Remarks on the Chart of the Head of the Passes.]

For additional information concerning history and construction of the jetties, see the valuable paper, with engravings, by E. L. Cortell, C.E., chief assistant engineer of the works, published in SCIENTIFIC AMERICAN SUPPLEMENT, No. 21, May 20, 1876. For additional photographic views of portions of the jetties see SUPPLEMENT, No. 28.

THE LAST OF THE RESOLUTE.

THE history of this old Arctic exploring vessel is of such an extremely interesting and even wonderful character, that, now it has been determined to break her up, it is not surprising that some desire should be felt to preserve some portions of her timbers as relics. The Resolute, originally a merchant vessel, was bought by the British Government for Arctic service, and it will be remembered that she was one of the three vessels which, in 1854, Sir E. Belcher, who had been sent out in search of Sir John Franklin, found himself compelled to abandon off Melville Island, the ship being so completely blocked in by the ice that it was deemed impossible for her ever again to be moved. The crew reached home safely with their companions from the other vessels, but the Resolute was looked upon as lost until, in the summer of the following year, it was discovered off the coast of Labrador by an American whaling vessel, whose captain took her to New York, where, the British Government having abandoned all claims to the vessel, she was bought by order of the American Congress, and, after being thoroughly repaired and equipped, was sent across the Atlantic as a present to Queen Victoria, who went down to Southampton to receive the gift in person. It is in remembrance of this graceful and generous act of international courtesy that it is now proposed to construct out of the timbers of the old Arctic ship some article of furniture to be presented to the President of the United States. The design for a secretaire, represented in our engraving, is the work of a working joiner employed at the Dockyard at Chatham, where the Resolute is now being broken up. The top is to be covered with morocco, bordered and embossed. The front panels will contain carved medallion portraits of Her Majesty and the President of America; the side panels, Arctic subjects, also in relief; and the space at the back of the table corresponding with the front panels will be furnished with a set of six drawers on either side, the handles of which will be formed by two hands (male and female) grasping each other, symbolic of the goodwill existing between the heads of the two countries. The top cornices of the eight corner pedestals will be appropriated to carved representations of the Arctic and Antarctic circles and the American and English flags crossed, and the busts of celebrated Arctic explorers will support the cornices. Since the date upon which she was handed over to Her Majesty by the United States officials, the Resolute has been moored either in the Medway or in one of the dockyard basins, the only use made of her being for the purpose of carrying out various experiments in connection with an improved method of fixing ship's scuppers. For the above particulars and for the sketches from which our engraving was made we are indebted to Mr. H. Biscoe, London Wharf, Chatham.—*London Graphic.*

RAILWAY TUNNELS.

THE *Inter-Ocean* has been collecting statistics of railway tunnels, and finds the more important of such structures to number 957, with a total length of 291 miles. They are distributed as follows:

Great Britain, 140 tunnels and 87½ miles; France, 259 tunnels and 82·6 miles; Belgium, 20 tunnels and 4·07 miles; Germany and Austria, 270 tunnels and 51¼ miles; Italy, 76 tunnels and 19¾ miles; Switzerland, 5 tunnels and 4·08 miles; North America, 115 tunnels and 33 miles; South America, 72 tunnels and 9 miles. Of English tunnels the most noted for magnitude and difficulty of construction is the Kilsby on the North-Western Railway, length 1·33 miles, cost $1,500,000, chiefly from nearly a fifth of its length being in quicksand saturated with water. The Nerthe tunnel in France is nearly three miles long, and cost $2,090,076; The Blaizy tunnel 2½ miles. The largest tunnels in Germany are between Offenburg and Constance. There are 15½ miles, 29 tunnels of various lengths, the longest 5,600 feet. The longest and most interesting tunnel in Switzerland is the Hauenstein, 1½ miles long. The one of chief interest in Italy is the Mount Cenis, 7½ miles in length. The principal tunnel in America is the Hoosac tunnel, which is 4·75 miles in length. The Mount Cenis tunnel is the longest railway tunnel.

DESIGN FOR A SECRETAIRE PROPOSED TO BE MADE FROM THE TIMBERS OF THE OLD ARCTIC SHIP "RESOLUTE," FOR PRESENTATION BY THE BRITISH GOVERNMENT TO THE PRESIDENT OF THE UNITED STATES.

NEW TESTING MACHINE.

THE testing machine constructed at the works of the Paris, Lyons, and Mediterranean Railway Company at Paris (M. E. Marie, engineer-in-chief), of which we publish an engraving below, is the most important machine of its kind. It is designed simply for tension, and arranged for a maximum pull of 100,000 kilogrammes, or nearly 100 tons. The whole construction of the machine, as will be seen from our engraving, is exceedingly simple. The test piece is connected at its lower end to a rod carried through from a hydraulic ram, working in a vertical cylinder placed below the bedplate. The weight of this rod and the ram, etc., is balanced by a counterweight suspended in a pit under the cylinder, but for the sake of avoiding shocks the connection between the chains and the counterweight is not direct, but through a system of springs conveniently placed within the counterweight as shown in figure.

The upper end of the test piece is carried by a link from knife-edges on the principal lever, from which the pull is transmitted to a second lever above the machine and thence down to the steelyard, which is placed conveniently for reading at the side of the machine. The maximum obtainable leverage is 600 to 1. The weight of the system of levers is counterbalanced by a special lever on the top of the machine. The weight on the steelyard is movable by means of a screw, and the load can be read either on a scale on the steelyard itself or on the peripheries of a system of graduated disks, arranged with a differential motion, placed at the outer end of it. This allows the load to be measured to (approximately, 0·005 of a kilogramme.

The hydraulic pressure is obtained either by a three-ram pump, from an accumulator, or by one of Thomasset's compressors. The extensions are measured by a kathetometer specially arranged for the purpose (not shown in our engraving), which allows of estimation to the one thousandth part of a millimeter. The machine is substantial and well designed, and its workmanship is very good throughout. The test piece itself is well exposed to view, as are the different parts, which also—except that they are a considerable height from the ground—are very accessible. We may add that a drawing of a machine on the same system intended to test chains has been exhibited by the same company. The chain is placed horizontally, of course, and the machine can take in a length of 30 meters, and exert a maximum effort of 100,000 kilos.—*Engineering.*

SELF-ACTING INTERMITTENT SIPHONS.

On Self-Acting Intermittent Siphons and the Conditions which determine the Commencement of their Action.*

By ROGERS FIELD, B.A., M. Inst. C.E.

IN the discussion of Mr. Barlow's paper on the upward jets of Niagara, read at the Plymouth meeting of the Association, I made a few remarks with reference to an improved form of self-acting siphon I had invented, the action of which depends on the power of falling water to drag air along with it, and I now, by request, will give a description of the action of this siphon, illustrated by a working model.

Before proceeding to describe the peculiarities of this siphon, it will be well to say a few words generally as to self-acting siphons employed for the intermittent discharge of fluids from vessels. The idea of employing siphons in

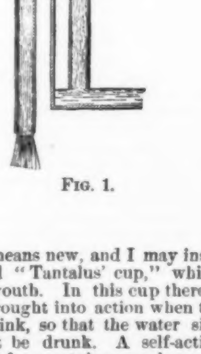


FIG. 1.

this way is by no means new, and I may instance the philosophical toy, called "Tantalus' cup," which many of us have seen in our youth. In this cup there is a concealed siphon, which is brought into action when the cup is raised to the mouth to drink, so that the water sinks away from the lips and cannot be drunk. A self-acting siphon has also been employed for emptying vessels used for measuring water, as in Osler's and Bickley's self-recording rain gauges, as well as on a large scale for reservoirs.

The chief difficulty to be overcome in applying siphons in this way is to start them or put them in action. In an ordinary siphon, such as that shown in Fig. 1, the siphon will not be put into action unless the water in the vessel rises above the top of the bend of the siphon, and it will be readily seen that if the siphon is any size, this will require a large accession of water in the tank, so that the siphon will not work except in cases where there is a large flow of water.

This difficulty can, to a considerable extent, be overcome by dipping the outer leg of the siphon in water as shown in

Fig. 2.

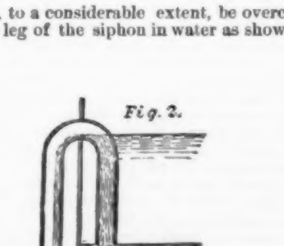


Fig. 2. The water which runs over the bend of the siphon will then drag a certain quantity of air with it, and drive this air out at the lower mouth of the siphon, and as the air cannot return in consequence of this mouth being sealed, the air in the outer leg is gradually reduced in tension below the atmospheric pressure. Whether this partial exhaustion of the air in the outer leg is sufficient to start the siphon depends on the quantity of water that runs over the siphon, but the quantity required will be much less than if the outer end were open, and it will not be necessary for the water in the vessel to rise above the top of the bend of the siphon.

Although the expedient of dipping the outer leg of the siphon in water greatly reduces the quantity necessary to start the siphon, the required quantity is still very considerable if the siphon is of any size, and further expedients have therefore been adopted to reduce this quantity. One of the simplest of these expedients is to have two siphons of different sizes connected together by a tube at the crown, and so arranged that the water runs through the smaller siphon first. The outer ends of both siphons are dipped into water, the smaller siphon then starts with a comparatively small quantity, and afterwards by means of the connecting tube exhausts the air from the larger siphon, and brings it also into action. This method was adopted by Professor James Thompson, F.R.S., in 1860, for his jet pump, and it was also carried out on a large scale in France in 1867, at the Reservoir de Mettersheim. In this latter case there are two siphons of about 28 in. in diameter, each of which is put into action by a smaller siphon of 6 in. in diameter.

This expedient, however, and several others which have been adopted, leave much to be desired, as they are to a certain extent complicated, and yet do not sufficiently reduce the quantity required for starting the siphon to enable it to be used in many cases. The method which I am now about to describe is both simpler and much more effective.

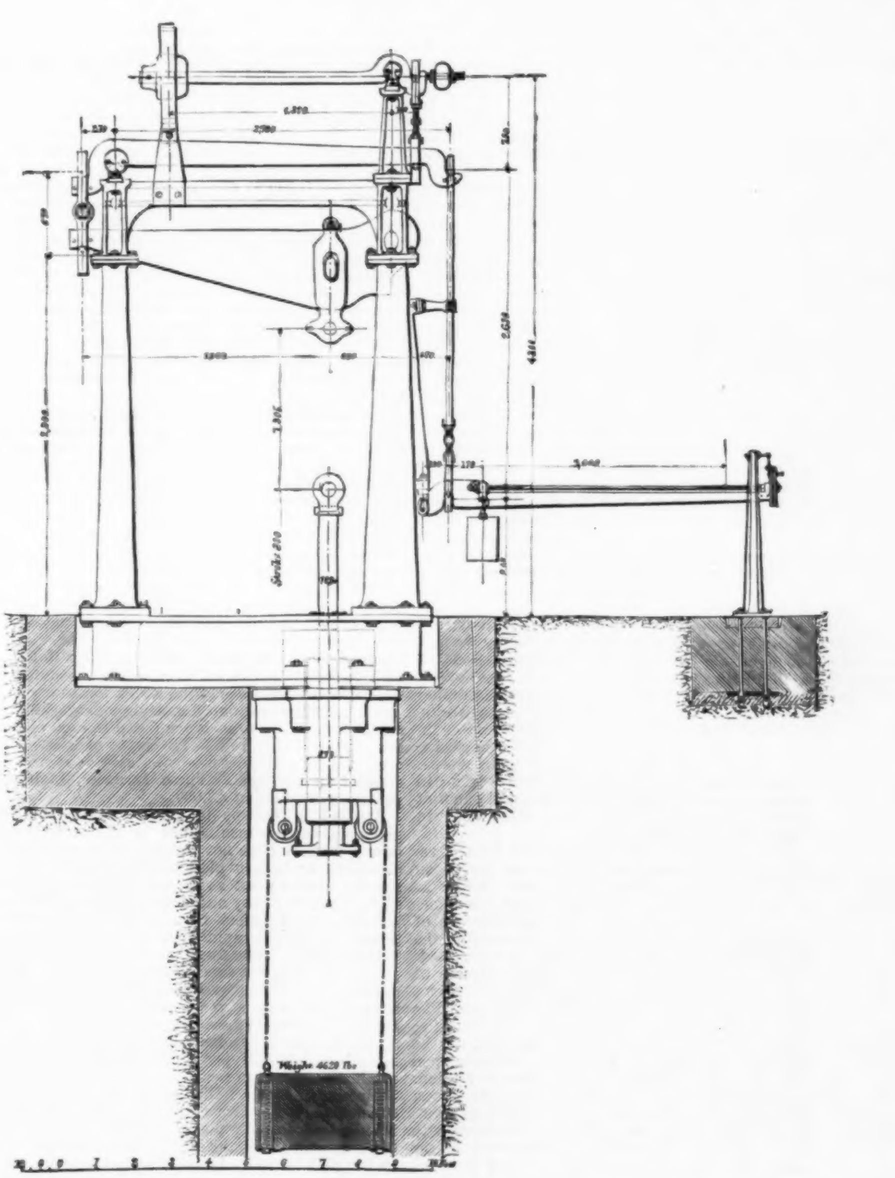
In an extensive series of experiments which I tried some years ago on siphons, with their outer legs dipped in water, I was much puzzled by finding that the quantity of water, necessary to put a siphon of given size into action, varied in the most unaccountable way at different times. The only difference that could be perceived between the cases in which the siphon started and those in which it did not start was, that in the former case air bubbles escaped freely at the mouth of the siphon, whereas, in the latter case, under apparently the same conditions, very few bubbles came out. At last the idea suggested itself to me of making a portion of the siphon in glass, so as to see what was going on inside the pipe, when the cause of the irregularity was at once discovered. Sometimes the water which ran over the bend adhered closely to the sides of the pipe, at other times a portion of it would fall more or less clear of the sides. When the water adhered to the sides it produced very little effect in displacing the air, so that only a small quantity of air was driven through the water at the mouth of the siphon. When on the other hand the water fell clear of the sides, it produced a great effect in displacing the air, and large bubbles of air at once escaped from the mouth of the siphon.

I pursued the investigation further by producing artificial irregularities in the pipe, and I then found the more completely I could throw the water clear of the sides of the pipe, the greater effect it produced in expelling the air and starting the siphon. The form of siphon which I have finally adopted as most effective is shown in Fig. 3, and in the working model.

The siphon consists of two concentric tubes, A and B, the outer one, A, being closed at the top, and steadied and supported by three radial ribs projecting from the inner tube, B. The annular space between A and B constitutes the ascending or shorter leg of the siphon, and the inner tube, B, the descending or longer leg. At the upper mouth of B is fixed a conical shell, C, projecting inwards clear from the inner surface of the tube, B. The lower mouth of B dips into a discharging trough, D, which has a weir, E, level with this lower mouth. The action is as follows: When the vessel is full, the water begins to trickle over the edge of the conical shell, C, and is so directed by the shell as to fall toward the center of the tube, B, quite clear of the sides, thus producing the maximum effect in displacing the air. The action of the siphon soon commences, and continues till the water in the tank is lowered to the level of the lower mouth of A, after which air is admitted by that mouth to the siphon, and the action ceases.

In some cases the quantity of air admitted at the end of the discharge, though sufficient to stop the siphon, is not sufficient to fully charge it with air, so that the next discharge will commence before the water in the vessel has risen to its full height. To obviate this, the best expedient is a secondary siphon, F, fixed in the trough, D, and put into action by the discharge from the larger siphon, A B. When this discharge has stopped, the siphon, F, continues in operation, so that the water in the trough, D, is drawn off, the lower mouth of the pipe, B, unsealed, and the larger siphon fully charged with air. Presently, also, the action of the secondary siphon, F, is also stopped by the admission of air When the vessel is filled, and water trickles over the shell, C, the trough, D, is again filled up to the level of the weir, and the siphon, A B, becomes sealed.

There are other minor conditions which affect the commencement of the automatic action of the siphon, such as the roughness of the top of the conical shell, C, the ratio of

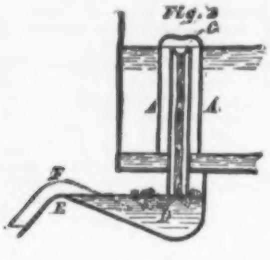


TESTING MACHINE, CONSTRUCTED BY THE PARIS, LYONS, AND MEDITERRANEAN RAILWAY COMPANY.

* Paper read before Section G of the British Association at Sheffield.

the area of the tank to the area of the siphon, the length of the siphon, etc., but these I will not go into.

In conclusion, it is evident that the above form of self-acting siphon will be of great practical use for a number of purposes. I will merely mention one, namely, that of flushing sewers by means of small quantities of water which ordinarily run to waste. Take, for instance, a drinking fountain; the water which escapes from it is, under ordinary circumstances, absolutely useless for flushing purposes.



Collect this water, however, in a tank with a large self-acting siphon, and as soon as the tank is full, be it in one day or in several days, the siphon will be brought into action, and the contents of the tank discharged with great rapidity. The trickle from a drinking fountain would start a siphon of as much as 10 in. or 12 in. in diameter of the improved form, and would, therefore, flush a sewer of considerable size, say nearly 3 feet in diameter.

FURNACES.

THE following treatise on glass and other furnaces is from the forthcoming report of C. Colne, Esq., U. S. Commissioner to the Paris Exhibition:

Europe has gone much ahead of this country in the use of gas furnaces, and they have in every instance proved quite economical. The question of fuel—one of great importance in Europe—has had the effect of stimulating their adoption, and wherever they have been put up, a considerable saving of fuel has been the result. France, Belgium, and England have been the foremost in adopting them. It is to be regretted that, so far, in this country but few gas furnaces have been put up. Aside from their economy, gas furnaces offer many advantages; the heat is under easier control, and may be graduated from an intense degree when melting to one sufficiently low to work the glass. Some of the objections urged against the Siemens furnace are their great cost, difficulty of management, liability to explosions, and the necessity of keeping skillful and experienced persons to manage them. The gases, traversing in pipes from the generators to the regenerators, are constantly condensing in tarry matter which must now and then be burned, an operation which is exceedingly disagreeable to the neighborhood, owing to the dense smoke. Notwithstanding these and other minor drawbacks, the great economy of 40 to 50 per cent. upon the fuel, in some cases 75 per cent., and the great cleanliness and easy management of the heat, ought to be by themselves sufficient inducements for their general adoption.

Though these furnaces have been used quite extensively in metallurgy with great success, in this country we find but three glass houses using them, viz.: Burgin & Sons, of Philadelphia, the Lenox Plate Glass Co., and the Crystal City plate glass works. In Europe we find quite a number of firms using them; in England, five plate glass works, twelve window and bottle houses, and one flint house; in France, seven plate works, ten window and bottle works, and nine flint factories; in Germany, three plate works, eight window and bottle houses, and twelve flint works; in Belgium, four plate works, one window house, and one flint factory. These furnaces have also been introduced in Russia, Portugal, Hungary, and Austria.

Recently a new system of gas furnace without the regenerating principle has been introduced among European manufacturers. The Boetius furnace is much simpler in construction than the Siemens. The gas generator is somewhat similar to that of Siemens, but the gases, instead of passing through regenerators, are conducted directly to the furnace with a sufficient quantity of air and there ignited. The air, by passing through passages under the bottom of the furnace, serves to cool the bench and thereby receives a certain degree of heat extracted from the hot bricks. The furnaces do not cost as much to construct as a regenerating furnace, they are easy of management, and the heat can be readily regulated. With a few changes, an ordinary open fire furnace can be altered into one of the Boetius system. They possess all the advantages of the Siemens furnaces, with the exception that the economy of fuel is not so great. An economy of 30 per cent. is claimed, and even more with fuels of inferior quality. We are fully convinced of the advantages and convenience of gaseous fuel, and we think the day is not far distant when gas will be used not only in the melting furnaces but also in the annealing furnaces, leers, and pot arches, as well as glory holes, in fact, wherever fuel is used.

Many other styles of gas generating furnaces are used in Europe, such as the Thomas & Laurens generator, for peat and wood; the Beaufume system, applied principally to generating steam; the Ten Brink, also applied to locomotives and steam boilers, vaporizes from nine to ten kilogrammes of water per kilogramme of bituminous coal, and is perfectly smokeless. These different systems, with suitable modifications, can be applied to glass furnaces.

Mr. Emile Gobbe, of Aniche, France, exhibited a model of a furnace, showing a combination of coke and gas furnace, with which it is claimed an economy of 70 per cent. is obtained, owing to the fact, it is said, that all the coke made can be sold to metallurgical establishments. This furnace has been applied to two glass houses in France, but is yet under trial, and no definite results have been obtained.

We also wish to call attention to a furnace which has been introduced in this country by the Société Générale de Métallurgie, of Paris. These furnaces are built upon the Ponsard system, consisting of the usual Siemens generator or a hot air generator; in the latter case the grate is suppressed and the coal is held in a fire-brick basin. The gas coming from the generator rises to the fire chamber of the furnace, but before combustion takes place it is mixed with a sufficient proportion of hot air coming from the regenerators. The heat escaping from the fire chamber, after having done its work, is conducted to a regenerator under the furnace, made somewhat in the same style as the Siemens. Instead, however, of one of the regenerators receiving the gas from the generator and the other the air to be mixed in the furnace and having four regenerating chambers, the Ponsard system uses but one chamber. This regenerating chamber is made up of a number of passages adjoining one another, one series of which receives the hot gases after combustion, and the other receiving the air to be heated by the absorption of heat from the adjoining hot canals. This system is, therefore, continuous, and simpler than the Siemens. It is claimed that a regenerating furnace will last one year in a glass house; some have been known to last three or four years when applied to other purposes than glass making. The regulation of gas and air is under perfect control, and can be graded as circumstances require. This system is now in operation in two melting furnaces and one annealing oven in France. An economy of fuel from 30 to 70 per cent. is claimed by their use. As these proportions are so very wide apart it would be interesting to know why such difference exists. Messrs. W. Sellers & Co., of Philadelphia, Pa., proprietors of the Edgemoor forges, write to the inventor that the system applied without grates works admirably with anthracite. The cost of these furnaces is said to be but two-thirds of that of the Siemens patent.

In the Austrian section Mr. Rosenegger, of Innsbruck, Tyrol exhibited the plan of a new gas furnace used in his factory. A gas generator furnishes the gas, which is conducted by suitable passages to the fire chamber of the melting furnace. The gas in its passage to the fire chamber is met by a current of heated air blown through iron pipes. The gas and air are regulated by suitable valves so as to insure a properly proportioned mixture. After combustion in the furnace the hot gases escape through an iron pipe which leads to a drying oven for drying sand, cullets, etc. Whenever this drying oven is not used, the heat, before escaping to the outside air, is allowed to go still further and enter another oven used for drying wood, peat, etc., used as fuel. The hot air supplied for mixing with the gas is derived from a current of cold air blown into the chamber where the iron pipe for the exit of the hot gas is laid. This cold air coming in contact with the highly heated pipe, absorbs the heat from it, and, by means of other pipes, is conducted to a suitable channel, where it mixes with the gas. Mr. Rosenegger, the manager of the works, has these furnaces in operation for the manufacture of plate-glass, and makes about 6,000 square meters of plate monthly. This furnace appears to be a simple combination of gas and hot air under pressure, but it is to be supposed that the iron pipes being under the influence of a very hot temperature must rapidly be destroyed by oxidation. The inventor, however, asserts that it gives entire satisfaction.

The difficulty of obtaining good homogeneous pots, and the serious losses experienced by their breaking in the furnaces, have led inventors to devise furnaces with chambers and compartments instead of pots. Prominent among these furnaces is that of Mr. Fred Siemens, of Dresden, who has applied it in his bottle factory. This furnace is constructed to take advantage of the increase of density glass acquires as it becomes more melted. It is composed of two large chambers separated in the middle by a wall. In the first compartment the batch is put, and as the glass, under the action of the gaseous fuel, commences to melt, it flows through a passage left open in the separation wall and reaches the second chamber. Directly after leaving this chamber it passes over a low wall built across the furnace; in so doing it is exposed in a very thin layer to the action of the heat, and rapidly becomes quite liquid. The glass now continues its course forward, and reaching a third wall having an opening at the bottom, it gradually reaches to the front of the furnace or chamber, from which it is drawn for working. Thus is the operation of melting and working glass made continuous. The heat is regulated in each chamber to suit the purposes required. The layer of glass does not exceed 16 inches in thickness; the glass is therefore more accessible to the heat. These furnaces, including the gas generator, cost about $3,000.

Applied in Europe to bottle-making, this system has given satisfactory results, but in the manufacture of window glass they have not yet proved so successful. So long as cullets or broken glass alone are used, the glass is of suitable quality; but as soon as batches are introduced the glass becomes grainy and lumpy. These defects are attributed to an imperfect refining and to the wear of the fire-bricks, which are rapidly cut away and the pieces mixed with the glass. The duration of the basins, so far as experimented, has not exceeded three months. Window glass made in these furnaces was shown in the exposition, but it appeared to be of a very imperfect quality. Should these defects be remedied, as they probably will be, these furnaces offer so many advantages and secure such an economy in fuel—at least 50 per cent.—that it would be unwise to condemn them at present.

Messrs. Chagot, of Blanzy, France, bottle manufacturers, constructed a gas furnace to do away with pots, and substituted a tank in their place. This furnace is 22 feet long, 6½ feet wide; the tank is 18 inches deep, and is capable of melting 26,400 lb. of metal at each operation.

Other styles of furnaces have been proposed with tanks and gas generators by Mr. Flamm, of France, for the manufacture of plate glass, with what success, however, we have not been able to ascertain. Should suitable furnaces be devised to do away with pots, they will be welcomed by most of the manufacturers who have been under the domination of the autocrat of the glass house, *i. e.*, the pot maker.

In connection with the question of gas for fuel, we think it surprising that, with the abundance of liquid fluids we have in this country, no one has yet applied our petroleum successfully in glass furnaces. From recent experiments made in Europe, it has been proved incontestably that, with suitably devised furnaces, this fuel is capable of producing a great heat and a marked economy. We have heard recently that petroleum has been successfully applied to the manufacture of iron in the oil region of Pennsylvania. If this is successful with iron, why should it not be with glass?

Mr. Audouin, a French engineer, with a very simple apparatus for burning heavy oils of petroleum, consisting simply of an injection of oil mixed with air, succeeded in evaporating 12 to 15 kilogrammes of water per kilogramme of oil burnt.

Mr. Ste. Claire Deville, the celebrated chemist, starting upon the idea of Mr. Audouin, devised an apparatus which he applied upon a locomotive on the "Chemin de fer de l'Est." The fire-box contained a cast-iron grate cast in one piece, the bars of which were set in front of the fire-box and were quite short; the upper part of the bars were of concave, semi circular form. Two fire-brick fire bridges were built, one front and the other back in the fire-box. The whole fire-box was lined with fire-bricks. Air was admitted to the fire-box between the grate bars as usual; the quantity admitted was regulated by means of a door. The operation is as follows: The oil arrives to the short grate bars by means of properly arranged pipes in front of the fire-box, and is conducted by the concave gutters; coming in contact with the heated fire-box, it is vaporized and mixed with the air which penetrates between the bars. With this simple arrangement a good combustion was obtained, and the locomotive upon which the apparatus was mounted continued to run for 2,300 miles on regular trains without stoppage. The result of the experiment showed an evaporation of 10 kilogrammes 90. of water, while the best agglomerated coal bricks only evaporated 7 kilogrammes 90. These experiments were carried on with heavy tar oil from the Paris gas works.

In other experiments by Mr. Ste. Claire Deville, with a carefully prepared apparatus, the evaporation of water with heavy Pennsylvania petroleum reached 15 kilogrammes 30. per kilogramme of petroleum, and with ordinary petroleum 14 kilogrammes 14., very nearly double the amount obtained with bituminous coal. In all furnaces using petroleum it is essential that the vapor of petroleum and air should be thoroughly mixed before combustion is reached. An increase of pressure and the heating of the air have also a marked economical result.

In conclusion of this chapter on furnaces we wish to say that we have the assurance of one of the managers of the largest iron mills in this country that metallurgy at the present day could not be carried on successfully and economically without the assistance of gaseous fuels. We hear with pleasure that a few of our glass manufacturers have already introduced gas furnaces, and the day is not far off when they will supplant the old direct fire furnaces entirely.

THE ROLE OF PATHOLOGICAL ANATOMY.

Inaugural Address of Professor J. COHNHEIM.

Translated for the SCIENTIFIC AMERICAN from *Le Progrès Médical.*

I.

IN the whole course of his studies, there is no date more memorable to the physician than the day on which he enters, for the first time, into the wards of a hospital, than the day when he commences his clinical studies. All the studies with which he has until then been occupied, the natural sciences as well as normal anatomy and physiology, present themselves to him under the aspect of pure sciences, which are studied and cultivated for their own sake, for the sciences with which the medical art is connected in a general manner, have, in all cases, only adventitious relations with it. Until then, not only has the young physician encountered in the lecture rooms many auditors not aiming to embrace the medical career, but he has generally not yet had any very intimate connection with his professors. All at once, the whole of this changes, as soon as the clinic becomes the theater of instruction. Here there is no longer any one who follows any other standard than that of medicine; everything here forcibly teaches the full gravity of the medical vocation; but likewise speaks of the benedictions that it wins; and as soon as scientific studies bear upon a patient, the conscience immediately awakes to the fact that here there exists something much more than simply to understand, and to explain. *De te narratur historia;* it is a man, like ourselves, who has become a subject of observation, but seeking aid and compassion, and having the right to demand them. Henceforth the instruction no longer addresses itself to the intelligence alone; it appeals both to the heart and the character.

Surely no one will deny they are the most beautiful sentiments that are awakened, they are the most beautiful sides of human nature that are touched. This revolution in the progress of studies is accompanied by a true and not a little advance, which is very advantageous, we must believe, to all the habits and to the manner of thinking of the student. But then, why precisely at this epoch, when they are on the point of passing from the semester of juniors to that of seniors, why do we so often see physicians hesitating, troubled, discouraged? It is not that they are dismayed by the extent of what still remains for them to apprehend; that fear is a stranger to young minds; it is even still less the sentiment, that a beginner cannot experience, of the imperfection and uncertainty of the medical art. The cause, then, must be sought elsewhere. If I do not mistake, it is much oftener the feeling, imposing itself with a startling clearness on the young man, of an undeniable solution of continuity between his previous and his future studies, the conviction that all the application and all the pains that he has expended to acquire normal anatomy, and, above all, normal physiology, scarcely serve him in the face of the enigmas that place themselves before him at the bed of the patient. In truth, has he not the right to be astonished when he sees a man of his own race, yellow, brown, or olive color, like a Malay or a mulatto, when he finds on the back of another a mass of tissue, with which he could hardly until then find any other analogy than the fatty hump of a camel; or when exploring with the finger the anterior ridge of the tibia of one seemingly well formed, he finds, in spite of the teachings of anatomy, that it is not sharp but very blunt and positively rounded? And, then, what has become of the laws of physiology? With what admiration has not the student heard spoken of, the power possessed by the animal organism of preserving unchangeable its proper temperature in the most diverse circumstances, in the midst of heat as well as in the midst of cold, during sleep as well as during the most active work: and there he finds a man peaceably in bed whose skin is burning, and in whose axilla the thermometer shows a temperature surpassing the normal by three or four degrees and even more. He is thoroughly versed in the laws of the circulation, he has studied the complicated mechanism, so interesting in its complication, that maintains the tension of the blood, strong in the arteries and feeble in the veins; he is imbued with the conviction that, in the veins, contrary to what happens in the arteries, the blood flows with a relative uniformity; finally, he has followed with zeal the experiments explanatory of the nature of the sounds of the heart! And now he has before him a patient whose radial artery is depressed under a slight pressure of the finger, while the veins of the neck have the aspect of great, hard, distended cords; or he even finds the most evident pulsations in the jugular veins, and his ear, applied to the cardiac region of the patient, perceives, instead of those that were familiar and intelligible to him, sounds altogether unusual and hence very surprising. After having come to regard the absence of albumen as one of the characteristic properties of urine, what will he think of it when he sees a specimen of that fluid on being brought to the boiling point take the form of

a coagulated mass of albumen? More than one will be tempted to ask himself if there are many species of men, some obeying the laws of physiology and others escaping them; or if truly physiology, resting in great part on experiments made on animals, is applied and related directly to the human organism. And in truth they are not always the worst students who jeer at the doubtful services rendered to physicians by the physiology of dogs and frogs. Indeed, to resolve the apparent contradictions that I have just pointed out, to re-establish the continuity between normal physiology and anatomy on the one hand, and clinical on the other—there is the role that intercedes with the modern physician for pathological anatomy.

Pathological anatomy, say you? How expect of an anatomical science the clearing explanations of the variations of normal heat, of the oscillations of the tension of the blood, of the anomalies of secretions?—of a science studying man only when the heat of his body has disappeared, when the circulation has been stopped for some time, and when all the glands have ceased to secrete. If for the understanding of the functions of the healthy organism normal anatomy is already of limited utility, is it true that pathological anatomy can very much better explain morbid processes? To reply up to a certain point to these very natural questions, I shall ask your permission to carry the discussion a little farther.

Our manner of reasoning on anatomical facts leading us to explain the permanent identity in the same external circumstances of the vital phenomena of men by the identity of structure of the organs of their bodies, it followed immediately and logically, that it was necessary to seek the cause of all modification of phenomena arising independent of external change, in an alteration of the constitution of the corresponding organ. It is, indeed, from this idea that pathological anatomy was born. In the works of the old anatomists at the head of whom the illustrious Vesalius placed himself, may already be found some data on the abnormal state of certain parts of the body; but the history of our science only dates truly from Morgagni, whose fundamental work bears this significant title: *De sedibus et causis morborum.* Pathological anatomy is not a simple annex of pure anatomical studies; they are the pathologists, on the contrary, who have knowingly created it with the design of placing it, if I dare express myself thus, at the service of the clinic. And we cannot place too high a value on what the clinic owes to it, and, above all, pathology. We can almost say that before then pathology had no real existence. In order to edify in this respect, it sufficed to ascertain, according to the observations on patients gathered in preceding centuries, from what disease the patient suffered; too often this would be pains lost, because the means of determining surely were at fault. Indefinite, vague, and equivocal terms have given place to very precise appellations and definitions, since we now know enough to look for the origin of certain dropsies in very appreciable and very positive lesions of the heart, the cause of numerous paralyses in hemorrhages, softenings, or other localized lesions of the brain. Pathological anatomy alone has rendered this progress possible, without which modern pathology could not exist, that is to say, the localization of diseases. For if, truly, in an apparatus so extraordinarily complicated as the human organism, every lesion, no matter where it is produced, may entail a general trouble on the economy, we can only define the nature of that trouble after having determined the seat and the character of the primitive lesion. This proposition is so familiar to us to-day, that if we wish to classify our knowledge of pathology, it seems almost impossible to us to follow any other principle of classification than that of localization. It is entirely by the advantage of pathological anatomy that we have reached this position; for its teachings alone have brought about this progress in practice, thanks to their fecundity and to the certitude inherent in them—a certitude which always makes of an anatomo-pathological result the most exact characteristic of a disease, and, as I have just said, our best method of scientific determination. This does not say that without pathological anatomy all diagnosis would be impossible, nor even that it would remain uncertain. No, clinical methods have also made in the last century, in great part under the impulse of pathological anatomy, such considerable progress that to-day the diagnosis of most diseases may be exactly established during life. The curve of temperature is no less pathognomonic of typhoid fever than the intestinal ulcerations; the rice-water discharges are even more characteristic of cholera than the results of the autopsy, and from the diastolic souffle, accompanied by the strengthening of the cardiac shock and a bounding pulse, we may conclude the existence of insufficiency of the aortic valves just as well as if we had examined them after death. In reality, for the diagnosis of similar diseases, relatively simple, we may to-day relinquish the autopsy. If, however, we still practice it after the fatal termination of these diseases, it is no longer for experienced men any more than a means of verifying themselves, and from this point of view, moreover, it has quite an inestimable value for students. But he who has seen many autopsies knows too well that ordinarily the affair is not so simple. Aside from epidemics it is certainly the least number of men, who, remaining healthy up to the mortal disease, succumb to an acute affection without complications. More often many are combined to constitute the whole of a morbid table, or series, of multiple groups of lesions of new and of old date, in part independent, in part derived one from the other; and no matter how great to-day may be the perfection of the methods of clinical examination, physical and others, no one will give the slightest reproach to the physician if the autopsy reveals such and such lesions which could not be suspected during the life of the patient.

Nothing demonstrates in a more striking manner the importance that attaches at present to pathological anatomy for the determination and classification of diseases than the promptitude with which a new disease is accepted and classed, without contradiction, and by all, as soon as it is established that a definite anatomical state has been constantly observed. In order to prove it, I will recall the chapter of diseases of the spinal cord, which, in a little more than ten years, has totally changed its aspect, since neuro-pathologists have learned to complete the precise detail of clinical symptoms by an equally careful examination of the spinal cord. It is even because pathological anatomy has slowly applied to this subject its methods (however insufficient for diseases of the nervous centers), that a system of denomination was preserved, in many other cases sooner replaced by an anatomical nomenclature. If there still remain names like tetanus, chorea, hypochondria, hydrophobia, it is because, up to the present, we have not any certain anatomical basis by which to denominate these diseases. Will the future bring it to us? Will an abnormal state of excessive irritability of the spinal cord ever disclose its anatomical signs? Who knows? Nevertheless, at present the innumerable and brilliant results obtained by pathological anatomy authorize us to believe that all the diseases clearly characterized by their clinical symptoms are likewise characterized by well-defined anatomical alterations; and notwithstanding the number of checks sustained in the study of the brain of epileptics and melancholics, this laborious problem is without cessation courageously undertaken by new eyes and new hands.

What gives to the searchers the hope of going further than their predecessors, is their legitimate confidence in the superiority of their methods of exploration. They are the same for anatomy, and these two branches of anatomical science, in perfecting their technique, are very often reciprocally aided. Like normal anatomy, gross or *macroscopic* pathological anatomy employs, in the first place, for its preparations the knife, the forceps, and the scissors; when necessary, it likewise requires injections and macerations; and on occasion it resorts to the proceeding of making sections after freezing, carried here in Leipsic to such a high degree of perfection. Still greater, if it be possible, is the identity of methods between normal histology and pathological histology. And it is not only because the perfections of the microscope are equally profitable to the two; it is because each of them absolutely obeys like the other the variations of the dominant doctrines of histology. At the epoch when capital importance was attached to the examination of objects "all warm and all living," the cells of sarcoma or of cancer passed directly from the operating room to the heated objective; to-day innumerable solutions of coloring materials adorn, that is to say, burden, the work table of every histologist. Absolute alcohol is the terror of accountants of pathological institutions as well as of those of histological institutions, and the microscope reigns as master in the laboratory of histologists and embryologists just as in that of the micro-pathologist.

But as great as the progress that has been already made and that yet will be made in anatomical and histological technique may be, as well founded as we may be in pursuance of the hope of discovering by our prolonged works, details yet unknown, have we on that account the right to believe that in this way, and in this way alone, we shall attain our end, or even that we shall approach very near to it? As for normal anatomy, it is beyond doubt. When at an epoch perhaps still far off, every visible part of the human body shall have been exactly known and well described, when, moreover, we shall know every phase of evolution that man follows in all its details, when we shall even be able to comprehend the harmonic arrangement of our body, to resolve mechanically the "problem of our corporeal form," then normal anatomy will have filled its task without having required anything else than the pure anatomical technique. For normal anatomy, minute or gross, is a purely morphological science endowed with all the captivating charm that the study of organic forms exercises on those who devote themselves to it with zeal and liking. But if you seek and hope for the satisfaction of these morphological tastes, flee from pathological anatomy! The most beautiful and most attractive forms are for the most part destroyed when they become the object of anatomo-pathological examination. Who can reconcile the image of a muscular fiber filled with fat or calcareous material with the incomparably more elegant striation of the unaltered fiber? Who will change the impression, so agreeable by the repetition of variations in its design, that a transverse section of the kidney produces, for that which arises from the devastated connective woof, and the barren cysts of a contracted kidney? Ought not an eye morphologically constituted to be wounded when, instead of the rich anastomotic plexus of ganglion cells, its gaze encounters an irregular assemblage of fibers and nuclei, or an altogether amorphous detritus sprinkled only with enormous nucleated cells?

(*To be continued.*)

PILOCARPIN IN INTERMITTENT FEVER.

By GASPAR GRISWOLD, M.D., House Physician to Bellevue Hospital.

THE treatment of intermittent fever naturally divides itself into measures which have in view the control of the paroxysms, and others intended to prevent the development of the malarial cachexia. For the latter purpose, the sulphate of quinine has been generally adopted by the profession; to accomplish the former, many remedies have been employed at different times, but without any very satisfactory results. It has long been held by good authorities that the development of the cachexia depends in many cases upon the occurrence of a succession of paroxysms. According to this view, the system contracts a habit of having a chill, fever, and sweat periodically; the characteristic anæmia, debility, and lassitude develop as the result of frequent exhausting pyrexias.

It is well established that the prevention of the development of a single paroxysm diminishes the tendency to the occurrence of successive ones; indeed, many cases have been reported in which this alone has brought about a cure, no constitutional treatment being resorted to. That the profession has appreciated the importance of preventing a chill is well attested by the long array of measures which have been proposed for this purpose. It has been proposed to tourniquet the limbs, and thus arrest the paroxysm by preventing the congestion of internal organs. Sinapisms have been applied all over the body with the same end in view. Cups have been used over the spine, with the hope that some good results might be obtained from counter irritation in the region of the nerve-centers. Some one has advocated the application of cold to the surface, believing that the paroxysm would be prevented by the nervous shock so produced.

Others have claimed that a paroxysm might be prevented by bringing the patient fully under the influence of alcohol. Violent exercise before the hour when the paroxysm usually commenced has been said to act as a preventive by inducing diaphoresis. More often resorted to than any of the above are full doses of opium, and drachm doses of chloroform, taken internally. All attempts to prevent or abort paroxysms have been thus far so unsuccessful that treatment is now nearly always merely palliative, being simply an attempt to make the patient as comfortable as possible while he is passing through the different stages. After the paroxysm is over, quinine is given in large antiperiodic doses. If the fever be of tertian or quartan type, the next paroxysm may generally be prevented; if it be of the quotidian variety, the chances are about even that another chill will occur.

Now, what is needed is an agent which will antagonize a chill so soon after its administration that it will not be necessary to limit our efforts to preventing the occurrence of a second or third paroxysm, but will be possible to promptly cut short the first. I believe the muriate of pilocarpin to be such an agent. The essential conditions of a chill are a small, hard pulse, peripheral anæmia, and convulsive muscular contractions. Pilocarpin relaxes arterial tension, causes a determination of blood to the surface, and in the progress of the diaphoresis induced by it, brings about muscular relaxation. This theoretical antagonism receives clinical support from the following cases:

Case 1.—John H., thirty years of age, stated on admission to hospital that he had been suffering for two weeks from malarial intermittent fever, tertian type. He said that his chill usually lasted an hour, and was followed by high fever and sweating. He had never suffered from intermittent fever before, and was not run down or anæmic. He had his first paroxysm in the hospital on the day after his admission, the cold stage commencing at 11:35 A.M. The chill was well marked, the teeth chattering, and the whole body shaking violently. Three minutes after his chill was fully developed, pilocarpin muriat., gr. ¼, was administered hypodermically. In 1 min. 40 sec. he drew a long breath, like a sigh, his convulsed muscles relaxed, and his chill stopped. A minute later his skin was moist with a slight perspiration, which went on to well marked diaphoresis, lasting about twenty minutes. No noticeable ptyalism was produced, and the diaphoresis was not more profuse than that which ordinarily follows the hot stage of a paroxysm. Forty-five minutes after the cessation of the chill the man's temperature was 99⅕°. He requested to be allowed to leave his bed, asserting that his chill was over, and that he felt all right. He complained of no fever during the remainder of the day. Patient was retained in hospital for two weeks for further observation. At the end of that time, another paroxysm not having occurred, he was discharged cured. The one dose of pilocarpin muriat. was all the treatment he received.

Case 2.—James R., thirty-six years of age, had suffered for one week from malarial intermittent fever, quotidian type. The chills generally lasted about an hour and a half. No history of malaria previous to this attack; general health good. Admitted to the hospital in the afternoon; had a well-marked chill at 9:30 A.M. on the following morning. As soon as the chill was full developed, pilocarpin muriat., gr. ¼, was administered hypodermically. In 2 min. 50 sec. a long sigh of relief (like that mentioned in the preceding case) ushered in general muscular relaxation. Moderate diaphoresis followed, lasting about half an hour. No ptyalism. Temperature 99° an hour after cessation of chill. Patient considered his paroxysm at an end, left his bed to go about as usual, and reported that he felt no fever during the afternoon. He had no chill during the next ten days, and was, at the end of that time, discharged cured. He received no treatment beyond the single dose of pilocarpin above mentioned.

We omit several other cases cited by Dr. G., which were attended with equally favorable results, and in which the author gives the changes of temperature in the patient following the administration of the drug.

From these cases it seems fair to conclude:

1st. That the muriate of pilocarpin, administered hypodermically, will promptly cut short the chill of malarial intermittent fever.

2. That in a large proportion of cases so treated the paroxysm aborts, terminating in the sweat caused by the pilocarpin, there being no hot stage.

3d. That such abortion of a paroxysm is in itself sufficient to effect a cure in many cases.

4th. That such abortion of a paroxysm is a valuable adjuvant to treatment with quinine during the intervals.

5th. That a dose of pilocarpin sufficient to produce this effect acts gently, without causing exhausting diaphoresis or unpleasant ptyalism.

The promptness with which an adequate dose of pilocarpin interrupts a chill is suggestive of its possible efficacy in cases of pernicious intermittent fever, where prevention of the full development of a paroxysm is often of the first importance.—*Medical Record.*

A POSSIBLE CAUSE OF ROMAN FEVER.

WHILE studying the microscopic fauna and flora of the Roman marshes, M. Lanzi, of Rome, found in the cells of algæ got there certain dark granules penetrating into the endochrome, or into the chlorophyl of the algæ having this substance. These granules, sometimes separate, sometimes in groups, are more numerous the more advanced the algæ in the state of death; at length they fill the whole cells, which then look no longer green, but black, under the microscope, the algæ begin to smell and enter into putrefaction. M. Lanzi considers the granules in the nature of ferments, and they may be found in abundance in the dust of the Roman Campagna. Now, the pigment granules found in the liver and spleen of individuals suffering from malaria, says M. Lanzi, have quite similar properties to the ferment granules, and he accordingly infers that these marsh products may be the cause of the fevers which give that region so bad a notoriety.

MEETING OF PHILADELPHIA ACADEMY OF NATURAL SCIENCES—BIOLOGICAL AND MICROSCOPICAL SECTION—OCT. 4, 1879.

Dr. R. S. KENDERDINE, Director, in the Chair.

Dr. CARL SEILER, the lecturer for the evening, spoke upon

HISTOLOGY OF TUMORS.

He said he did not wish to enter too fully or too scientifically into the histology of tumors, as there is so much difference of opinion among students in regard to the morbid processes involved, and because he desired to adapt his remarks to the comprehension of all the audience.

All tumors were formally divided into Sarcomata and Carcinomata. They are still so named, but the sarcomata or *fleshy tumors* were considered harmless, while the carcinomata or cancerous were held to be malignant. The lecturer then said that there were many of the sarcomata as malignant as the carcinomata, the malignancy depending in great measure upon the position of the tumor and the proneness to secondary deposits of tumor elements in distant organs.

To illustrate, he called attention to the fact lately brought forward by Dr. S. W. Gross, of Philadelphia, that the round and spindle celled sarcoma of the long bones are by far the most malignant tumors, and that they usually formed secondary deposits in the lungs to which the patient succumbs. The same form of tumor in connection with other bones was not to be considered very malignant, and could be removed by operation with considerable hope of saving life.

The present division of tumors is into, first, those formed of *connective tissue* elements in various stages of development; and second, those formed of *epithelial* structures.

The presence of the so-called *cancer cell* or *spindle cell* was formally regarded as the certain evidence of a malignant growth, and until a period within the last ten years was so taught in our medical schools.

This spindle cell is also found in normal connective tissues, in embryonic tissues, cicatrices, etc., and although such distinguished histologists as Virchow, Billroth, and Rokitansky have endeavored to find a special cell indicative of the malignant nature of cancer, they have never succeeded. All are agreed that cancer should not be regarded as anything distinct, and that its cell elements are either identical with the embryonic or with the fully developed tissues.

The simplest form of tumor is found in granulating tissue, or what is commonly known as *proud flesh*.

When we make a section of such a neoplasm we find the cells present the simple round appearance analogous to the embryonic connective-tissue cell and precisely identical with the cells of the round-celled sarcoma. A* similarity also exists in the blood-channels of the round-celled sarcoma and embryonic tissue, they being without walls.

By throwing out prolongations and contraction of the embryonic cell condition the connective tissue cells are formed, and in granulating surfaces which go on to healing, we find the cicatrix made up of or containing the spindle cells. These two forms of cells, the one as found in simple granulating surfaces as well as in the round-celled sarcoma, the other as found in connective tissue and in the spindle-celled cancer have the power of inflicting the tissues. In this consists the special malignant characteristic. The apparent presence of the round cells in the spindle-celled tumors is owing to the transverse sections of the interlacing spindle cells, and are always so regarded.

The nature and character of the lipoma or fatty tumor, the osteoma and various tumors from admixture of these elements were referred to by the lecturer.

The fibroma was described as a tumor which in itself did not produce any dangerous symptoms, but might, indirectly, by its position.

The recurrent fibroma of the English surgeons must be looked upon as an encapsulated spindle-celled sarcoma, and the recurrence *in loco* of the tumors must be explained by the presence of tumor elements in the tissues outside of the capsule, which elements have the power of reproducing the neoplasm.

The second class of tumors, the epithelial, were then considered.

By irritation of the epithelial elements, or when the nutritive processes are actively stimulated, we have an undue development of these cells outward, constituting the form of tumor known as the papilloma or *wart*, the simplest form of epithelial tumor.

By the same process, limited by the thick and hardened epidermal layers at a later period of life, the cell growth extends inward in the direction of the least resistance, and the form of tumor known as the epithelioma results.

The adenoma or glandular tumors present the appearance of increased glandular elements. The proliferating epithelial cells may however fill up and enlarge the ascini to such an extent that finally the limiting membrane is broken through, and the cells continue to grow into the adjacent connective tissue, where we find nests of proliferating cells, usually of an elliptical form, from being pushed forward.

When the connective tissue predominates, or is greatly increased in amount, a hard scirrhous cancer will result. If the connective tissue fails to increase, and the epithelial cells develop to such a degree as to wither or overbalance it, then these cells, also breaking down from pressure, etc., form the soft variety of cancerous tumor. In conclusion, the lecturer said, the chief point which he desired to bring before the gentlemen of the academy was, that there is no such thing as a *cancer cell*, and whether malignant or not depends upon the infiltration of the new cell growth, position of the cell growth, and secondary deposits. The lecture was illustrated by diagrams and by a large number of beautiful slides showing the different varieties of tumors and their histological details. At the close remarks were made by a number of gentlemen.

Dr. Alfred Reed gave as a reason why the lungs are a favorite seat of secondary cancerous deposits, that they are formed by the same germinal layer of the embryo as the bones.

In reply Dr. Seiler said that tumors not originally situated in bones form secondary deposits of the lungs, and on the other hand, tumors of the bones form secondary deposits in other internal organs, and especially in glandular organs. He further said that it needed but a very few of the tumor elements carried to a distant point by either the circulation of the blood, or, as is more frequently the case, by the lymphatic circulation, in order to start a new point of development.

In proof of this the lecturer related some experiments lately performed in Germany, in the course of which a few cartilage cells taken from a cartilaginous tumor were ingrafted upon the cornea of a rabbit and also in the muscular tissue of another animal of the same species, which formed the starting points for similar growths as that from which they had been taken.

Other communications were received from members of the section. Mr. Potts presented a living specimen of Cristatella Idæ, lately described at a meeting of the Academy by Prof. Leidy. Mr. Walmsley, of the firm of R. & J. Beck, presented for examination an improved microscope, compact and economical, which could be used for dissecting and as a compound instrument.

On motion it was decided to hold the Annual Microscopical Exhibition on the first Monday of November.

TREATMENT OF THE DROWNED.

TWO THINGS TO BE DONE: RESTORE BREATHING; RESTORE ANIMAL HEAT.

RULE 1. *Remove all obstructions to breathing.* INSTANTLY loosen or cut apart all neck and waist-bands; turn the patient on his face, with the head down hill; stand astride the hips with your face towards his head, and, locking your fingers together under his belly, raise the body as high as you can without lifting the forehead off the ground (Fig. 1), and give the body a smart jerk to remove mucus from the throat and water from the windpipe; hold the body suspended long enough to slowly count ONE, TWO, THREE, FOUR, FIVE, repeating the jerk more gently two or three times.

RULE 2. Place the patient face downward, and maintaining all the while your position astride the body, grasp the points of the shoulders by the clothing, or, if the body is naked, thrust your fingers into the armpits, clasping your thumbs over the points of the shoulders, and *raise the chest as high as you can* (Fig. 2) without lifting the head quite off the ground, and hold it long enough to *slowly* count ONE, TWO, THREE. Replace him on the ground, with his forehead on his flexed arm, the neck straightened out, and the mouth and nose free. Place your elbows against your knees and your hands upon the sides of his chest (Fig. 3) *over the lower ribs, and press downward and inward with increasing force* long enough to slowly count ONE, TWO. Then suddenly let go, grasp the shoulders as before and raise the chest (Fig. 2); then press upon the ribs, etc. (Fig. 3) These alternate movements should be repeated 10 to 15 times a minute for an hour at least, unless breathing is restored sooner. Use the same regularity as in natural breathing.

Fig 1.

Fig. 2

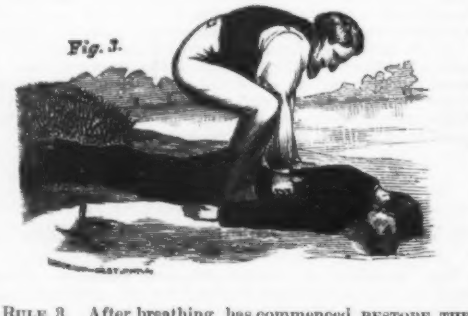


Fig. 3.

RULE 3. After breathing has commenced RESTORE THE ANIMAL HEAT. Wrap him in warm blankets, apply bottles of hot water, hot bricks, or anything to restore heat. *Warm the head nearly as fast as the body, lest convulsions come on.* Rubbing the body with warm cloths or the hand, and slapping the fleshy parts, may assist to restore warmth and the breathing also. If the patient can SURELY swallow, give hot coffee, tea, milk, or a little hot sling. Give spirits sparingly, lest they produce depression. Place the patient in a warm bed, and give him plenty of fresh air; keep him quiet.

BEWARE!

AVOID DELAY. A MOMENT may turn the scale for life or death. Dry ground, shelter, warmth, stimulants, etc., at this moment are nothing—ARTIFICIAL BREATHING IS EVERYTHING—is the ONE REMEDY—all others are secondary.

Do not stop to remove wet clothing before efforts are made to restore breathing. Precious time is wasted, and the patient may be fatally chilled by the exposure of the naked body, even in the summer. Give all your attention and effort to restore breathing by forcing air into and out of the lungs. If the breathing has just ceased, a smart slap on the face or a vigorous twist of the hair will sometimes start it again, and may be tried incidentally, as may, also, pressing the finger upon the root of the tongue.

Before natural breathing is fully restored, do not let the patient lie on his back unless some person holds the tongue forward. The tongue, by falling back, may close the windpipe and cause fatal choking.

If several persons are present, one may hold the head steady, keeping the neck nearly straight; others may remove wet clothing, replacing at once clothing which is dry and warm; they may also chafe the limbs, and thus promote the circulation.

Prevent friends from crowding around the patient and excluding fresh air; also from trying to give stimulants before the patient can swallow. The first causes suffocation; the second, fatal choking.

DO NOT GIVE UP TOO SOON. You are working for life. Any time within two hours you may be on the very threshold of success without there being any sign of it.

In suffocation by smoke or any poisonous gas, as also by hanging, proceed the same as for drowning, omitting effort to expel water, etc., from the windpipe.

In suspended breathing from effects of chloroform, hydrate of chloral, etc., proceed by Rule 2, taking especial pains to *keep the head very low,* and preventing closure of the windpipe by the tongue falling back.

The foregoing method, originally published by the State Board of Health of Michigan, has the sanction of other State and City Boards of Health, and is fully indorsed by the State Board of Health of Connecticut, and printed for general distribution as a life-saving measure.

INSECT PESTS IN LIBRARIES.

By DR. H. A. HAGEN, Professor of Entomology in Harvard University.

HAVING been invited to make a communication on the insects injurious to books and libraries, I am obliged to be very brief, even more than I should like to be, owing to the fact that most of the publications are not accessible here. An application to the National Library was without success, and there was not time enough to get an answer from Europe. Therefore it will be easy to observe the three golden rules for a speech given by Dr. Martin Luther:

> "Open thy mouth widely,
> Shout out strongly,
> Shut it quickly."

The first fact on record is given by Pastor Frisch in Berlin, who had observed the small larva of a beetle (*Anobium*) perforating transversely the thickest books. It makes a network of small passages, and, in some places, larger holes for its transformation.

This larva, as common here as in Europe, is the same which even now every library has to fight. The injuries observed by Frisch are well known to every librarian, and are to be found in old and seldom-used books. I saw once myself a whole shelf of theological books, 200 years old, traveled through transversely by some more adventurous larva.

Some twenty years later injuries must have been oftener observed. At least Mr. Prediger, in Leipsic, was induced to write, in 1741, a book of advice to bookbinders, which was republished in 1772. We find from an extract in the *Gentleman's Magazine*, May, 1754, that if the bookbinders were to make their paste of starch instead of flour, worms would not touch the books. He also recommends pulverized alum mixed with a little fine pepper to be put between the books and the covers and also upon the shelves—which would certainly transform such a library into a gymnasium for sneezing. For the more effectual preservation of books, he advises to rub the books well in the months of March, July, and September with woolen cloth dipped in powdered alum. I think he might have advised with equal propriety to rub the books with the second finger of the left hand, as the inspection of the books is the only important point of the advice.

The *Gentleman's Magazine* adds that it is remarkable that worms seldom attack books printed on English-made paper. It is overlooked in this statement that until 1690 only packing paper was made in England, and all other kinds of paper were imported from Holland. Therefore no old books, which are attacked by preference, printed on English-made paper, then existed.

Some years later the library in Göttingen seems to have been troubled in a serious manner. The Academy of Göttingen has published three prize essays on insects obnoxious to books, by Mr. Hermann, M. Fladd, and one anonymous writer. All three were reprinted in contemporaneous magazines, and many extracts made from them. I have not met with any of them here, and know nothing but the titles. The remedies proposed must have been very effective, or the insect decided to move into more hospitable quarters, as since that time nothing further is stated about such pests in Germany.

A few general rules for the preservation of libraries are given in the same year by Mr. Meinike. As a curiosity, I may be allowed to quote the substance of them. The rooms in which the books are ought to be heated, but as it is not possible to heat large libraries, the more costly manuscripts and incunabula should be kept in a small, warm, and at the same time well-ventilated room. Obnoxious insects should be trapped by water and lard placed in some rooms of the library. The rules conclude with the following words: It will not be necessary to do anything against insects excepting where a library takes only the place of tapestry or other decoration of the walls without being used. I have to state that the little beetle (*Anobium*) is the same which is so obnoxious to old furniture and old picture frames. No wonder that it considers old, not used books, as old furniture. The custom of preserving in libraries historical pieces of furniture is, therefore, probably a disadvantage for the books. Some papers for Sweden, France, and Italy I was not able to consult; they prove at least that in those countries mischief has been done to Swedish libraries. Linnæus speaks about a beetle (*Ptinus fur*) which had been very obnoxious to libraries in 1760; French reports speak of mites which cackle like hens, eat the outside covers of books and live on the paste, a kind of insect unknown to me. A memoir, by Pozetti, for Italy in 1809, is also known to me only by the title.

A species of white ants living in the most southern and western parts of France made immense ravages between 1825 and 1835. The little insect known only as living under stones or in old, decayed trees, had until this period never been injurious. Even its apparition in myriads after the falling in of an uninhabited house in Rochefort did not draw the attention of the people to the danger. Some time afterward more accidents happened. In a boarding house a whole dinner party fell suddenly from the third story down into the cellar. The attention of the government was drawn finally to the danger by the destruction of the naval archives and of the library of the marine department. It was necessary to secure every book and paper in tight-closing tin boxes. Constant attention proved to be the only remedy. Some years later the insect did less damage, and disappeared, as insect pests commonly do, without any apparent reason. The insect exists still in those parts of France, but without being obnoxious.

Concerning America, the facts published are few. Dr. L'Herminiet, a surgeon in Guadaloupe, has made a somewhat detailed report about the ravages done by a beetle called by him *Dermestes chinensis.* Everybody complained of the destruction of books, and the doctor himself lost about 4,000 volumes. The only remedy used with success was mercury in different kinds of preparation, surely not without danger for the owner of the books. Several interesting remarks are added. Some older books were exempt from injury, probably because the paper was made of different material. New books were only attacked after they had absorbed the humid air of the island and had become distinctly heavier.

Probably the same beetle made the extensive ravages in Cuba, about which Professor Poey in Havana has published a memoir. He calls the insect *Anobium bibliothecarum*. I am sorry to state that a reliable determination of both insects is still wanting.

The facts given so far seem to be rather harmless, but I cannot refrain from drawing the attention to the presence of white ants here and everywhere in the United States, sometimes, as, for instance, in Cambridge, in the near neighborhood of libraries or university buildings harboring valuable special libraries. I am obliged to state that twice in the United States books have been destroyed by white ants to a hopeless extent. In Springfield, Ill., fourteen years ago, all the bound spare copies of the State papers were stored in a closed room in the State House, and not looked after for some time. When the room was opened all were found in a mutilated condition.

Some years ago a Boston lady, a teacher in one of the freedmen's schools in South Carolina, who had gone away for a vacation of six weeks, found, on returning, the whole library of Bibles and prayer books destroyed. The copies kindly forwarded to me were less damaged, and therefore retained.

Perhaps the allusion to a danger which has only existed in exceptional cases may seem too darkly colored or even sensational. This, of course, has not been my intention. But we must know that we live surrounded by such enemies, and that great destruction can be effected. The circumstance that our white ant is very closely allied to the French species, which lives in a similar manner, and was for a century innoxious till it suddenly became a formidable pest, makes the knowledge of the danger imperative. It should not be forgotten that Alexander von Humboldt stated half a century ago that the rarity of old books in Mexico was in consequence of the depredation of white ants.

Only a few days ago I received from Mr. J. A. Lintner, of Albany, N. Y., the following written communication: "The book which I spoke to you as injured by cockroaches bears the following memorandum: 'Presented to the State Cabinet by Antonio de Lacerda, to illustrate the works of *Blatta Orientalis*, January 2, 1807.' It is an English pocket dictionary, bound in cloth. The back and sides are eaten in patches through the enameling down to the threads of the cloth. As it stood on the shelf, the cover must have been partly open, and at the outer edge of this the paper lining had been eaten for the space of about one-quarter of an inch along the entire margin to get at the coating beneath.

"Some years since we had a large edition of one of our Museum Reports stored in the basement. The cockroaches, which infested this part of our building, attacked the backs and the exposed cover of each upper volume, eating through the coating of the cloth, as above described. The edges of the volumes were also badly soiled by their excrements. This injury could be removed by the binder with sandpaper, but no way was known by which the other could be remedied. Perhaps a hundred volumes were so badly injured that we do not like to distribute them."

Perhaps it may be too assuming, and too much like bringing coals to Newcastle, to propose a few regulations for libraries in the presence of librarians to whose care are intrusted libraries comprising millions of volumes.

As far as I can judge by the reports of large and small libraries, more than the third part, even in the larger libraries, is intended for frequent circulation, and, indeed, does circulate very rapidly. This part needs, of course, no prevention at all. The second and third is intended for the advance of knowledge, and is used more or less frequently for this purpose. Here begins the necessity of a stronger supervision of the books.

The third part, finally, consists of books which are less used, often only once in a year, or even in several years. Nevertheless, such books cannot be omitted by libraries. This part, indeed, needs the greater care, the more so as it consists mostly of rare or costly books. There are sometimes very rare books injured by *Anobium*. The different methods employed to kill the larvæ are mostly not indifferent, at least for the binding. I should like to propose here a remedy perfectly harmless and perfectly efficient, namely, to put such rarities under the glass bell of an air pump and to draw out the air. After an hour the larvæ will be found killed. Of course this is only to be applied to rare books or costly bindings.

If we recapitulate briefly what is so far known about insects obnoxious to libraries, only two insects remain—the well-known *Anobium* and the white ant. I say only two, leaving aside the cockroach, as libraries will not often be stored in cellars. The beetles will certainly not do any notable injury if the books are used frequently. Against white ants, which would be an exceptional danger, constant attention would be the only remedy.

Some precautions against them are published by myself in the *American Naturalist* for 1876. I am happy to acknowledge that so far no serious damage has been done to libraries here by obnoxious insects.—*Library Journal.*

THE REARING OF A SILK-PRODUCING MOTH.*

(*Attacus Cecropia.*)

FOR a long time past attempts have been made in Europe to rear several exotic species of the Bombycidæ. Sometimes this has been done for the purpose of acclimating them, and in the hope of utilizing the silk which they all produce, and which, notwithstanding its usually gray color, might possibly serve for the fabrication of goods possessing remarkably solid qualities. But it is not the economic side of the question entirely that leads most amateurs to make such experiments. It is rather the pleasure of seeing issue forth from their cocoons those superb gigantic moths whose wings are ornamented with colors and designs so different from those exhibited by our native species of Bombyx.

Their caterpillars, too, are very beautiful; and, aside from the difficulty met with in Paris in procuring a sufficient quantity of the oak upon which the majority feed, they are generally easy to rear, being slow in their movements and quitting the leaves but little, thus allowing of their being left in the open air on branches simply placed in a bottle of water. We have had the good fortune to rear the caterpillar of *Attacus cecropia*, one of the most beautiful species known, and especially remarkable for the changes it undergoes at every month. At the beginning of the year 1878, the Acclimatization Society, having procured a large number of cocoons of this pretty Saturnian, distributed them with its well-known generosity, and one of my friends and colleagues, M. Berce, received a certain number of them. He awaited the appearance of the moths, obtained a coupling of the sexes, and subsequently some eggs, part of which he offered to me, and we both made our preparations to bring the rearing of the insects to a successful issue. The first individuals that M. Berce saw appear were all males, and the last were all females, so that the number of sexual unions was quite limited. The able entomologist hastened to prick the fecundated females, under the impression that this process would oblige them to lay their eggs more completely and rapidly. From this there resulted eggs in pockets; and this, we will observe, does not usually take place in nature with our large Bombyces—*Attacus pyri*, for instance, which lays its eggs in very small groups on the trunk and branches of fruit trees, and *Attacus cynthia*, the pretty Chinese moth now completely acclimated in France, and the female of which lays rows of six, eight, ten, or more eggs on the back of ailantus leaves. The eggs of the Cecropia resemble those of the majority of the large species of *Attacus*, such as the Yama-Mai and Pernyl, and are yellowish, irregularly spotted with brown. The little caterpillars which issue from them about a dozen days after they are laid are black and have spiny tubercles of the same color. Before long, some are noticed that have two rows of dark-yellow dorsal spots. On attentively observing, M. Berce and I thought that we saw here evidences of a first moult, and which had escaped the notice of many entomologists. We agree with M. Blachard, who, in his "Metamorphoses of Insects," says, *apropos* of experiments in rearing undertaken formally at the museum, that the caterpillar of these species moults five times. However this may be, there is here a first change, which is followed by another and greater one after the second moult. The caterpillars are then wholly of a beautiful orange-yellow, and the tubercles with their verticels of spines are black, as are also the head, the stigmata, and the little scale-like legs. The membranous legs are greenish, with one or two black spots. After the third moult, the caterpillar undergoes a complete change; it is now yellow-green with a sky-blue back, and exhibits two dorsal rows of tubercles, the first four of which are large and spherical, and of a carmine or coral red, with a row of six verticillate black spines, and a seventh spine likewise black at its apex. The base of each of these tubercles is surrounded by large black projecting points, sometimes confluent, and usually of the same number as the spines. The other dorsal tubercles are sub-cylindrical, and of a beautiful dark-yellow, with small black spines at the extremity. The sides show two rows of tubercles of a beautiful turquoise blue. At the fourth moult the caterpillar changes but little, it is more blue, the yellow tubercles are brighter, the stigmata dark, the head and legs of a yellow-green, and the latter have also a black spot at their base. The crown of false legs remains blue. At the fifth moult the red tubercles have become pale, and are of a light garnet, and their spines have become shortened and look like obtuse cones. The black spots situated at their base are much larger. At the instant of moulting, these spots, as

FIG. 1.—ATTACUS CECROPIA.

1. The Eggs.—2. Caterpillar on issuing from the egg.—3. Caterpillar after the first moult. —4. Caterpillar after the second moult.—5. Caterpillar after the third moult.—5a. Its tubercles.—6. Caterpillar after the fourth moult.—7. Caterpillar after its fifth moult: mean size at the period of spinning.—7a. Its tubercles.

FIG. 2.—ATTACUS CECROPIA,—COCOON AND MOTH.

* A. L. Clement, in *La Nature.*

well as the spines, are of the same color as the tubercle, which is itself almost colorless. It is quite a long while before the black coloration appears. After every moult, the caterpillar, as soon as it gains a little strength, turns around and eats up almost entirely the skin it has just shed, and this before taking any other food. This habit, however, is not peculiar to this species. When about to spin, the caterpillars have become greener, the large tubercles darker, the blue tubercles almost white at the extremity, and the dorsal region whitish. During the course of rearing them, which lasted about six weeks, they willingly remained on the branches, provided the latter were renewed often enough to furnish them always with an abundance of fresh food, but later on this was very different. If they no longer judged the branches a proper place for locating their cocoons, they resolutely left them. If they were now picked up in the room and replaced on the branches, they quitted the latter anew and went and took refuge in the folds of a curtain, under a chair, or elsewhere, but they rarely remained in the branches. This, moreover, sometimes happened when they found in the latter some threads of silk which had been cast by another caterpillar, and which served them as a starting point for spinning their cocoon. To give an idea of the state of my experiments at this moment: I had reared my caterpillars in the open air of my workroom, and they were now about four inches in length. One could hardly take a step without crushing some of them; they were everywhere—in the dining-room, kitchen, parlor, bedroom, closets, and even in the beds.

The majority spun cocoons which were quite variable as regards size and color. Some were fusiform, of close texture, hard and adherent throughout their whole extent to the branches and leaves; while others, of a less regular shape, had been formed between leaves that were further apart. There were some that were immense; the accompanying figure represents one of medium size. In all cases the cocoon is composed of a double envelope, and it is said that, as regards yield of silk, the exterior one is greatly the superior. These cocoons are usually of a ferruginous brown; but just after being spun they are of a nacreous white. The silk is very strong, and it is said that on drawing it from the spinnerets just as the caterpillar is about to spin (as is done with certain diseased silkworms) a large and solid thread is obtained which appears to be excellent for the fabrication of fishing lines.

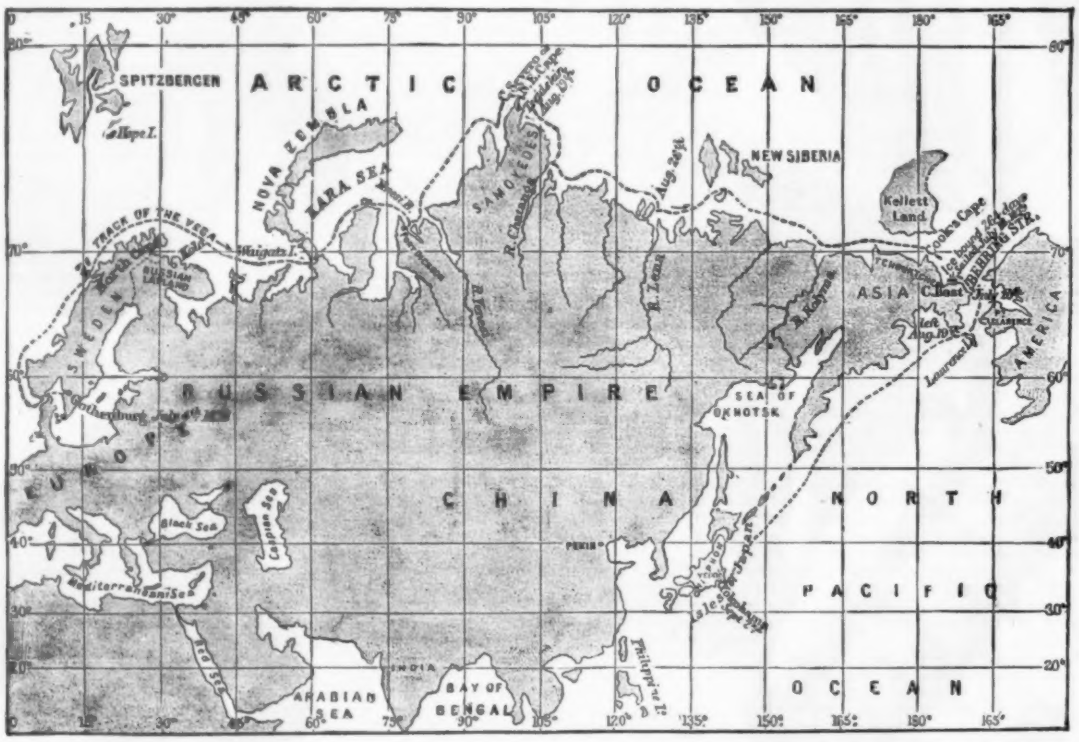
The chrysalid, like that of all the large Bombycidæ, is blackish, and passes the winter in the cocoon. The moth which issues from it in May has but one generation a year, and measures about five and a half inches in spread of wings. To give an exact idea of it, it will only be necessary to add to the previous figure some description as to the color. The four wings are dark-gray above, with a transverse band, which is white or ocher-yellow within, and a bright brick-red outside. The crescents are of a yellowish-white in the center, red at the circumference, and edged with a black line. The apical angle of the forewings bears an oval black spot intersected by an ash-blue circle; and above this spot there is a sinuous white line and some carmine blotches. The marginal bands and lines are yellowish-gray. The antennæ, which are bipectinnate in both sexes, are almost black, and much wider in the male than in the female. The eyes are brown; the thorax is red, with a white or light-yellow collar; and the legs are red. The abdomen is very pretty, presenting in each sex those differences of form usually observable in the Bombyces. Each of its rings has a red and white band separated by a black line, except the first, which is entirely red, and the last, which is gray intermixed with red and black hairs. On the side of the abdomen is a row of beautiful red spots surrounded by dark-brown; and on the ventral surface the rings are bordered with white, with a series of red spots surrounded by black.

We fed the caterpillars on leaves of different kinds of plum. They also ate the leaves of several other fruit trees, but always returned to the plum when they were allowed their choice. We may add, in conclusion, that during the present year we have successfully reared the second generation of this species.

NORDENSKJOLD'S NORTH-EAST PASSAGE.

ALTHOUGH the world no longer takes such an intense interest in North-west or North-east Passages as was felt in earlier days, when it was believed that such a route if found practicable would be a short cut from Europe to the Indies, yet Professor Nordenskjöld's feat represents the solution of a highly interesting geographical problem. This distinguished *savant* all the more deserves his laurels since from early manhood he has devoted himself to explorations in Spitzbergen, Greenland, and the north of Europe. The joyful news lately brought was that Nordenskjöld had at last got free from the ice which, since September 28, 1878, had bound his ship, the Vega, off Koljutchin shore, almost within sight of open water, and had arrived with all his crew safe and sound at Yokohama, Japan. During their enforced imprisonment, the professor and his companions unintermittingly pursued their scientific labors, and have reaped a rich harvest of spoils.

The details of the expedition are as follows: Leaving Gothenburg early in July, 1878, the Vega spent some days in the Kara Sea, and on August 19 doubled Cape Severo or Tchelyuskin, the most northerly point of Asia, and which hitherto had never been rounded by man. Mountains rise south of the Cape, and animal and vegetable life abound. The Vega coasted over a smooth sea, marked on the charts as dry land, to the mouth of the river Lena, and after a glance at the Siberian Islands, where the ice prevented any lengthy exploration, turned southward toward Behring's Strait, and was finally forced to settle for the winter, on Sept. 28, at Kolintchin, a short distance beyond Cook's furthest point, Cape Vankarema. Here the expedition were ice-bound for 264 days; but game—bears, reindeer, foxes, and wild fowl—was plentiful, and occupations were many. Human society, too, was not absolutely wanting, as only a mile off was land, the Tschutschi Peninsula, where there were villages of some 4,000 Tchik-tchi, pleasant, friendly people. The cold was intense; but the expedition enjoyed excellent health and spirits, and not a single case of scurvy occurred. The shortest day experienced lasted only three hours, when the upper limb of the sun alone was visible. On July 18 the vega started again, passing Cape East two two days later, and reached Japan without further accident than slight damage from a gale. Professor Nordenskjöld believes that with a little further experience the voyage will be perfectly safe, and considers that no difficulties await skillful sailors between Japan and the Lena, where, as the Lena taps Central Siberia, there is a large prospective trade. —*London Graphic.*



THE NORTH EAST PASSAGE—MAP OF THE ROUTE TAKEN BY THE NORDENSKJOLD EXPEDITION.

EXPLORATION IN CENTRAL ASIA.

THE grand Russian exploring expedition to Central Asia has had its scope largely extended. Professor Sorokin, Botanist Pelman, Artist Simakoff, and the Engineers Liapunoff and Sokolovsky have arrived at Tashkent, and other scientific and military members are on their way thither from Orenburg. Captain Zouboff, the commander of the naval section of the exploration party, instead of proceeding to Tashkent, has gone direct from Kazalinsk to Khiva, where he is making arrangements for the survey of the Oxus. In order further to make this successful he has taken with him a steamer purchased on the Volga at Samara, at a cost of 40,000 rubles. As originally arranged, the expedition will survey the railway route from Kazalinsk to Balkh, via Tashkent; it will explore the course of the Oxus from Balkh to Khiva, and then will examine the ancient bed of the Oxus as far as the Caspian. It is further reported from Tiflis that Colonel Danoff has arrived there with an expedition for surveying the Caucasian peninsula with a view to determine whether it is practicable to join the Black Sea and Caspian by a navigable canal. The expedition has been set on foot by the Minister of Ways of Communication himself, who also is evincing great interest in the scheme for diverting the Oxus into the Caspian. The result of the success of both projects would be to open up Central Asia to Europe, and to allow of goods to be conveyed by water direct from the Black Sea to Bokhara and the Afghan frontier.

VOLCANIC PHENOMENA AND EARTHQUAKES DURING 1878.

THE statistical review of volcanic phenomena during 1878, which Prof. Fuchs has recently published, and which forms the continuation of many previous statistical accounts of the same nature, shows the usually large number of *twelve* eruptions in the course of the year. Most of them occurred in remote localities, and gave evidence of the activity of volcanoes which were generally but little known and which are all difficult of access. It is true, however, that Mount Vesuvius also, the last eruption of which had taken place in 1872, but which already during 1877 had shown symptoms of the re-awakening of the volcanic process, again entered into a period of activity on April 20, 1878. The mountain ejected ashes, frequent slight shocks occurred, a thick column of smoke ascended, and at the end of September a scanty flow of lava took place. This increased during the night of September 22-23, and the lava descended as far as the Atrio del Cavallo; but afterward the volcanic activity sank down into the ordinary solfatara state, which was only interrupted by little periodical explosions on October 11, and by the flow of little streams of lava from November 1 to November 9.

At the southern point of South America, active and hitherto unknown volcanoes were repeatedly seen by passing ships, viz., on January 10 and 18; one of them is situated upon the middle island in the English Narrows, the other on the South American continent in about 48° 56′ lat. S.; this one was conspicuous by a majestic column of smoke, ejected from a high snow-clad mountain, and rising to a height of some 300 meters.

At the same time a great eruption occurred in the island of Tanna, the well-known and very active volcanic island in the archipelago of the New Hebrides. On January 10, at 10 A.M., between the so-called Sulphur Bay and the old crater, a new eruption cone formed; the outbreak was accompanied by a mighty tidal wave which inundated a great part of the island. In spite of its violence the eruption lasted only a short time, but on February 4, a second outbreak followed which also did great damage.

Simultaneously yet another eruption happened. Its seat was the large island of Birara, in the group of New Britain. The northern part of the island was completely devastated, and its coasts rendered inaccessible, through enormous masses of pumice stone which covered the sea for many miles. Formerly, no volcano had been known there. We have repeatedly referred to the masses of floating pumice stone in the vicinity of the Solomon Islands, through which, as Captain Harrington reported, ships had to force their way for two or three days It is very probable that this pumice stone originated from the eruption on Birara, and not from some submarine eruption, as was generally supposed at the time of the occurrence. It is true that there are two volcanoes in the Solomon Islands, the Semoya and the Lammat upon the island of Guadalcanar, but from neither were any eruptions reported during 1878.

The third eruption of February took place from the volcano Isluga in South America (lat. 19° 10′ S.), which mountain had been inactive since 1869. The outbreak was accompanied by a fearful earthquake, and so great were the masses of lava ejected that the villages of Cariquima, Carima, Sotoca, and Chiapa, all situated at more than five leagues distance from the volcano, were completely destroyed by the incandescent streams.

Smaller volcanic eruptions occurred from Mount Hecla (from February 27 to the end of March), from the Asamayama in Japan, from the Cotopaxi near Quito (in October), from the Tepaco, the Sitna, and the Isalco in San Salvador. The eruptions in the Aleutian and Society Islands were of greater importance. In the volcanic series of the Aleutian Islands, the volcanoes on Amukta, Tscheguluk, and the Vsevidok volcano (almost 2,800 meters high) on Umnak were in eruption. In the Society Islands, according to the report

of Captain Evers, the islands of Raiatea and Borabora were completely devastated by the action of volcanoes.

At the end of the list of lava eruptions, Dr. Fuchs records the great mud eruption of one of the well-known mud volcanoes near Paternò in Sicily. After repeated shocks of earthquake in the province of Catania, spreading over two months, this eruption began on December 10, numerous craters ejecting streams of mud with great noise. Several of these craters were continuously active, as the mud was of little consistency, and freely permitted the ascending gases to escape. The others had explosions from time to time, as the crater basin was filled with much thicker mud, which prevented the gases from passing upwards until their tension was sufficiently high, and they ejected the mud in high rays. At the end of the year this mud eruption was still progressing with unabated force.

The number of earthquakes reported during 1878, amounts to 103. But amongst these there are many complete earthquake periods during which shocks and oscillations lasted with short intervals for hours, days, and even for several weeks in the same locality. If we would or could count all the separate shocks which occurred, a very high total would be reached. Thus in the comparatively unimportant earthquake of Zengg, twenty shocks were counted, and in the great earthquake of Terapaca, in the night of January 23, no less than forty shocks, while the oscillations lasted here almost without interruption until April 12. An earthquake on the island of Tanna (New Hebrides) lasted for four weeks, and in the province of Catania the oscillations succeeded each other almost without interruption from October 4 to November 19.

The earthquakes were most frequent in winter and autumn, thirty-nine occurring in winter, twenty-six in autumn, and nineteen each in summer and spring.

The most violent and most destructive of all these phenomena happened on January 23, in that district of Peru and Bolivia in which the terrible earthquake of 1868 took place. The province of Terapaca suffered more than any other. Here, with the earthquake of May 9, 1877, which in violence was hardly surpassed by that of 1868, a great and considerably extended period of frequently recurring oscillations had begun, amongst which the earthquake of January 23, 1878, was prominent by its particular force. At Iquique it began at 7.55 P.M., and the shocks continued during the whole night. As usual, the subsequent tidal wave did still greater damage than the earthquake itself, and this was particularly the case at Arequipa, Pica, Mantilla, Pisaqua, Arica, and Terapaca.

The earthquake on October 2, in the southern part of the republic of San Salvador, was also very violent. In the town of Incuapa almost all the houses were destroyed, and many of the inhabitants perished. In the vicinity a number of villages disappeared entirely. The motion of the soil was first undulatory and ended with a terrible shock.

Of European earthquakes the following must be mentioned specially:

On January 28, about noon, an earthquake shook the north-western part of France and the south of England. It was particularly distinct in Normandy, at Rouen, Havre, and Dieppe. Even in Paris the shock was so considerable that several houses were endangered. In England it occurred between 11:45 and 10:50 A. M., and was observed at Greenwich, London, Brighton, Southampton, Cowes, and several other places.

Repeatedly shocks were felt in north-western Switzerland and at the south-west corner of the Black Forest. The first and more marked phenomenon happened on January 16, and consisted of several shocks separated by short intervals. These shocks were noticed at Basel, Brugg, Solothurn, on the Swiss side of the Rhine, and at Lörrach, Schopfheim, Waldshut, etc., on the Badish bank. They recurred at Basel on January 17, and on March 29 they were again felt in the whole area described, and then even at Freiburg and Strasburg.

Other instances of repeated earthquakes are:

Innsbruck (January 3, 10, 11, February 2, August 9).

Gross Gerau (January 2, March 25).

Lisbon (January 26, 27, June 8).

Piedmont (repeated shocks on November 25).

Constantinople, Ismid, and Brussa (continual shocks from 19 to end of May).

The damage done by the last mentioned phenomenon at Ismid and Brussa, on April 19, was very considerable; the little town of Esmé was quite destroyed, and many inhabitants lost their lives. The English fleet, which happened to be anchored in the Bosphorus at the time, noticed the oscillations, and on board of one of the ships it was believed that the others were making torpedo experiments, and consequently looked out for shelter.

Less remarkable by its violence than by its enormous extent, considering its intensity, was the Low-Rhenish earthquake of August 26. The observations in this case were unusually exact and numerous, which gives additional interest to the occurrence. It began about 9 A.M., and was best observed in the city of Cologne. Here it consisted of an undulatory rising and sinking of the ground, which increared in intensity to such an extent that some buildings began to oscillate ominously. On the cathedral tower the smaller bell struck several times, and the wavering pillars in St. Gereon's Church caused such a panic among the congregation that all rushed out. In many parts of the city the walls of houses showed cracks. At the end of the oscillations a dull subterranean noise was heard and a second shock was observed by many persons.

In almost all localities in the Rhenish Province, from Cleve and Emmerich to Kyllburg, Ottweiler, and Montjoie the observations of the phenomenon were similar to those made at Cologne; the same was the case on the opposite bank of the Rhine, at Düsseldorf, Wiesbaden, Münster, and other places. At Aachen (Aix-la-Chapelle), five distinct shocks were noticed; at Elsdorf (on the Neuss-Düren Railway) no less than eighteen until the morning of August 27; and at Düren and Buir, their number was but little below this figure.

The area struck by the first shock, on August 26, at 9 A.M., may have measured over 2,000 geographical square miles, as its outlines may be indicated as follows: Arnsberg and Hanover in the north; Offenbach on the Main and Michelstadt in the Odenwald in the south-east; Strasburg, Paris, and Charelville in the south; Liége and Brussels in the west; and Utrecht in the north-west.

Prof. Klinkerfues has collected the most reliable observations of time and reduced them to the meridian of Paris. According to these calculations the earthquake happened at Cologne at 8h. 38·7m., at Strasburg at 8h. 39·9m., at Göttingen at 8h. 40·9m., at Hanover at 8h. 42·4m., and at Paris at 8h. 45·0m. If the starting point of the oscillations, according to number and intensity of the shocks, be supposed to have been situated about 2·5 geographical miles to the west of Cologne, the above indications of time give a velocity of the earthquake in the ground of 6·78 geographical miles, with a probable error of ± 0·48 mile. The depth of the original starting point is unknown. Prof. Klinkerfues is of opinion that it lay between 6·3 and 8·7 geographical miles from the surface. It is remarkable that the phenomenon was only noticed at the surface, and was all the more intense the higher the observer was above the ground. Many observations were made both at Cologne and at Hanover, which show that the oscillations were far more considerable in the upper stories of houses than in the lower ones. At Remagen the shock was so great on the upper floor of the school building that teachers and school children rushed terrified into the street, while on the ground floor the phenomenon was hardly noticed; the workmen on the towers of Cologne Cathedral saw the scaffolding oscillate to such an extent that they feared for their lives, and a water tank on the vault of the choir was almost entirely emptied. Yet not one of 1,100 miners working at a depth of 300 meters at Altessen noticed the least shock.

For a long time afterwards shocks occurred at Elsdorf and Buir. At the latter place they were observed on August 26, 27, 28, 29, September 2, October 24, December 3 and 10. Also in other places of the same area the shocks were repeated, so at Remagen (September 3), Wiesbaden (September 14), Osterrath and Crefeld (September 18), Cologne (December 10), Luxemburg and Namur (December 15).

With almost all earthquakes of slight intensity it is very difficult to determine to what class of earthquakes they belong. Thus in the Low-Rhenish earthquake no symptom points to any particular cause. We may surmise volcanic influence, because the most intense and most numerous shocks occurred near the north-western slope of the Eifel plateau; but with perhaps greater reason we may look for the cause of the phenomenon in the Rheno-Belgian coal district. Altogether the earthquake of August 26 seems to be but a link in a great earthquake period, which for some years past has been causing lasting changes in the coal deposits of that neighborhood. The names of Herzogenrath, Kohlscheid, Eschweiler, etc., recur in every one of Dr. Fuchs' yearly accounts, and apart from numerous weaker oscillations of small extent, considerable earthquakes occurred in this district from September 28 to November 12, 1873, and on June 24, 1877.—*Nature.*

THE BRONZE GATES OF BALAWAT.

Nine miles north-east of the cluster of rugged mounds and sandy ramparts which mark the site of the ancient Assyrian city of Calah, now known to the Arabs as the Mounds of Nimrud, there is situate a short distance from the bank of the Shor Derreh the long, low mound of Balawat, or "the Ruins." This mound has given its name to a small village of some 30 houses, which is situate a short distance to the south-west of the mound, and for this hamlet, with a part Mohammedan and part Christian population, the mound has formed the usual place of sepulcher; and it is owing to this that the fact of its containing treasures of the ancient Assyrian Empire was first discovered. During the digging of some graves on the site the workmen employed came upon a number of fragments of bronze plating, much broken and oxidized. Such fragments as were discovered being regarded as only relics of the infidels, trouble was fortunately not taken to search for more. The expeditions of Sir Henry Layard, Mr. George Smith, and others have taught the natives that there is a money value attached to these antiques by the Europeans, and so in course of time some of the bronze fragments, the largest of them not more than two feet in length, found their way to Mosul. Two of these fragments, and fortunately the best, found their way to the hands of Mr. Rassam, at that time in England, and were exhibited by him at a meeting of the Society of Biblical Archæology. By a fortunate chance, this first installment of the great brazen treasure of Balawat was extremely interesting, as when examined it was found to represent the payment of tribute to Shalmanesar III. (B.C. 859-825) by the maritime cities of Tyre and Sidon. No more fragments of the gates reached England until July of last year, when Mr. Rassam, who had always expressed a determination to have the remainder of the monument, brought to England with him, as the result of his expedition, two of the great brazen gates which for centuries had lain buried beneath the ruins of Balawat.

For a time the great plates of richly sculptured bronze, which are all that remain of the gates, were a great puzzle to the archæologists who examined them. The decay of the wood-work and the gradual accumulation of the earth above them had caused the bronze scrolls, which once had been straight and regular, to become loose from their framework and assume a most confused and bewildering shape. But the skilled knowledge of Mr. Ready, of the British Museum, through whose hands so many masses of metal have passed from unintelligible confusion to correct and beautiful restoration, soon solved the second problem, and it is to him archæologists owe the restoration of these splendid brazen gates. The bent, broken, and decaying mass of metal has gradually been straightened, joined, and cleaned, until at last—thanks to patient toil and study—we have restored to us one pair of the great temple gates. The inscriptions found in the south-eastern portion of the mound were those of the King Assur-nazir-pal, and by him the temple was erected. Those who first examined these monuments were unable to read the inscriptions which accompanied them on account of the thick coating of dirt and oxidation, and hence in the first instance these larger gates were attributed to him. But they, having now been cleaned, are found to have been erected by his son, Shalmanesar III. This does not preclude some of the other three pairs of which portions remain having been erected by the earlier monarch. Indeed, the mention of gates "plated with bronze," and the fact that the second and smaller pair brought to England by Mr. Rassam are illustrative of hunting expeditions, a pastime of which Assur-nazir-pal was passionately fond, seems to point to this smaller pair having been erected by him. The smaller pair are in an extremely decayed condition, and it is doubtful if they can be restored.

Now that the fragments which Mr. Rassam brought to England have been cleaned and arranged, it is not a difficult matter to restore the largest pair of the gates which have been recovered, and thus to gain a knowledge of these wonderful works of art which twenty-seven centuries ago, fresh from the hammer of the brazier, stood before the temple of the war god, Nergal. The solid iron cores which strengthened the massive cedarwood posts of these gates show them to have been more than 22 ft. in height, with wooden posts, themselves more than 12 in. in diameter. The wooden framework of these doors was entirely—posts, styles, and all—covered with plates of rich bronze containing more than 85 per cent. of copper. The two leaves of the gate and the supporting posts give the width of the gateway to be 15 ft., so that there was presented to the view of the spectator on these huge portals more than 300 square feet of richly-worked bronze.

The decoration of the gates was by a series of long bronze ribbons or plates about 2 ft. in width and 8 ft. in length, which were laid horizontally on the wooden frame covering both the face and round of the post. Each of these scrolls was decorated by two tiers of sculptures in repoussé work, chased with a graving tool, illustrative of the campaign of Shalmanesar III. The tiers were separated from one another by a border decorated with rosettes, which were perforated to admit the nails fastening it to the frame. Each door was decorated with seven of these metal bands, making 14 in all. When we gaze at these splendid works of art, and build up before us these rich entrance gates to the temple of Shalmanesar (remarks a writer in the London *Times*, and his subsequent three-column description of them fully justifies the opinion expressed) we certainly must admit them to form one of the grandest historical monuments ever rescued from the grave of centuries.

EXPERIMENTAL GEOLOGY.

Geologists are popularly supposed to spend their time in examining the rocky masses which build up the earth's crust, in collecting and studying the relics of ancient life which lie entombed in many of these rocks, or in applying their knowledge to the construction of maps which mark out the distribution of the various rocks. And such, in truth, are the main lines of geological inquiry. Yet it would be wrong to forget that some of the knottiest problems in geology have been untied by men who have rarely wielded a hammer in the field, who have been utterly ignorant of organic remains, and who may never have laid down a single line upon a map. It was found, indeed, in the very infancy of the science, that the only chance of interpreting many of the phenomena which perplex the geologist was by calling in the aid of chemical and physical science. The prime object of geology is, of course, to reconstruct the past in the light of the present. But it is often impossible to guess how nature has been working in past ages in order to bring about the results which are now before our eyes, except by attempting to attain similar results by direct experiment in our laboratories. Observation in the field has naturally been the chief instrument in laying the foundations of geology; but observation finds a valuable auxiliary in experiment. There is unquestionably such a thing as experimental geology.

It is scarcely too much to say that experimental geology took birth in this country. At any rate, it is matter of history that some of the earliest and most important researches in this branch of the science were undertaken by Sir James Hall, of Dunglass, at once the disciple and the supporter of the famous Hutton. When, for instance, Hutton asserted that basalt had once been a molten rock, while his opponents ridiculed this assertion on the ground that such a substance, after being melted, would solidify into a glassy mass, it was Hall who silenced the cavil for a while by direct appeal to the crucible and the furnace. His experiments proved beyond contradiction that, under certain conditions of cooling, the molten mass might solidify as a stony substance, not to be distinguished from the original basaltic rock.

Since the days of Hall, geology has made considerable advance along the lines laid down by chemistry and physics; but the advance has been due not so much to workers in this country as to continental experimentalists. Among foreign chemical geologists, few have been more enthusiastic than the late Gustav Bischof, whose volumes are still our principal authority on the subjects to which they are devoted. While Germany has been represented by such men as Bischof, France has not been behind in the domain of experimental geology. Foremost among French experimentalists, who have successfully attacked geological problems is the accomplished director of the National *Ecole des Mines*. For thirty years M. Daubree has been working, more or less continuously, upon this track, and the results of his labors, collected and co-ordinate, have recently been given to the scientific world.*

Most of M. Daubree's researches, it must be confessed, are already familiar to the specialist. But to those who have not made a special study of experimental geology it may be well to refer to them, since they strikingly illustrate the manner in which experimental methods may be applied to the elucidation of geological questions. Any one who studies these investigations must admit that the chemist and the physicist, not less than the mineralogist and the biologist, have a fair right to be counted as fellow-workers with the geologist.

It is not pretended for a moment that the experimental geologist can imitate with anything like precision the conditions which occur in nature. Many of these conditions it is quite beyond his power to command in the laboratory. It was pointed out long ago by Sir James Hall that, in order to realize what goes on in the deep-seated portions of the earth, where mineral substances are subjected to the enormous weight of the overlying rocks, it is necessary to expose the substances on which we experiment to considerable pressure. The late M. Senarmont carried out some valuable experiments under pressure; and some of M. Daubree's most interesting results have been obtained under similar conditions. Such experiments are not undertaken without extreme difficulty, and even danger.

When water is very highly heated in closed vessels, the tension of the steam is often sufficiently great to tear open the strongest vessels as easily as though they were made of paper. Occasionally, however, the rupture is prevented, and results of singular interest are then obtained. Thus, M. Daubree has found that a piece of glass, which may be taken as the type of a complex silicate, after several days' exposure to the action of superheated water, is completely changed in character. The strong glass tubes in which the water was inclosed were found to be partly converted into definite hydrated silicates closely resembling some of the minerals called *zeolites*—minerals which occur not only in the cavities of eruptive rocks, but also in many mineral veins. It is notable, too, that in some of these experiments part of the glass was transformed into a crystallized anhydrous substance, identical with certain varieties of the common rock-forming mineral—*augite.* But the most curious result of the action of highly-heated water upon glass was the production of silica in a crystallized condition exactly like *quartz.* Quartz is one of the commonest of minerals; yet it is by no means easy in all cases to explain the conditions of its formation. The silica which we usually obtain in the laboratory assumes a gelatinous state, and dries up to a shapeless powder, utterly unlike the beautiful crystals which

* "Etudes Synthétiques de Géologie Experimentale." Par A. Daubrée Première Partie: Application de la méthode expérimentale à l'étude de divers phénomènes géologiques. Paris: Dunod, 1879, 8vo, pp. 478.

occur so abundantly in nature. But in M. Daubree's experiments under pressure, the quartz was artificially produced in crystals which in their minutest details closely mimic the natural mineral

It is true that the crystals of quartz thus produced are excessively small, but they are not a whit the less valuable on that account. The artificial crystal may be no bigger than a pin's head, yet if it possesses all the other characters of the native mineral, it is obviously as trustworthy a witness as to the genesis of the mineral as though it were a hundredfold the size. Had the forces which have been operating in the production of the microscopic crystals been allowed to act for a longer time, it is only fair to assume that they might have produced results of corresponding magnitude. Time is indeed one of the most important factors in the production of geological phenomena, and the shortness of human life places the experimental geologist at a manifest disadvantage. Yet if we are unable to carry on experiments in the laboratory for successive generations, we may occasionally avail ourselves of experiments in nature which are performed under conditions almost as clearly defined as those of the laboratory. Not the least interesting parts of M. Daubrée's volume are those in which he describes certain chemical changes that have been effected by thermal springs since the days of the Romans.

The ancient Romans, who were fully alive to the value of hot springs, appear to have paid considerable attention to the thermal waters which gush forth at Bourbonne-les-Bains, in the department of Haute-Marne. Roman masonry, based on piles, has been constructed around some of the springs, and above these Roman workings modern structures have been erected. Toward the end of 1874 some borings were carried through the deposits at the bottom of the old Roman baths, and from these deposits a large number of relics were obtained. The examination of a layer of mud brought to light no fewer than 4,700 Roman coins. Four of these were gold coins of Nero, Hadrian, Faustina junior, and Honorius; 265 were silver coins, principally of Imperial and Consular types, associated with a few Gaulish coins. Of bronze there were as many as 4,468—large, middle, and small brass—ranging over a considerable period. With the coins were associated other objects, such as statuettes, pins, and rings, in bronze, gold, lead, and iron. Now for sixteen centuries the mineral waters of these springs, the temperature of which is now between 58° and 68° Centigrade, have been uninterruptedly acting on these various metals, and the results are therefore equivalent to a series of laboratory experiments extending over this lengthened period. Hence we look with considerable curiosity to the kind of action which has taken place and to the nature of the resulting products.

Beneath the mud which contained the coins and other objects described above, there was a layer of conglomerate, formed of fragments of sandstone and grains of sand, cemented into a coherent mass. The agglutinating material consisted of mineral substances which had been slowly formed by the solvent action of the heated waters on the coins and other metallic objects. Careful examination of the products has brought out the interesting fact that many of them are identical with minerals which occur in veins, and that they are in many cases as beautifully crystallized as the natural products.

It is needless to cite a long catalogue of these recently formed minerals, but among the more characteristic the following may be named: *cuprite*, or red oxide of copper, occurring in octahedral crystals, and evidently an alteration-product of the bronze; *chalcosite*, or sulphide of copper, sharply crystallized in forms which resemble those from Redruth in Cornwall; *copper pyrites*, or yellow copper-ore, such as forms the staple mineral in most of our copper-lodes; *purple copper-ore*, better crystallized than most of the native mineral; and *gray c pper-ore*, a rather rare substance, beautifully crystallized in tetrahedra, whence its name *tetrahedrite*. In some cases a single specimen from the old baths may contain all these copper-bearing minerals, just as a similar assemblage of species may be occasionally found by the miner in a copper vein.

Were it not that we are anxious to avoid mineralogical technicalities, it would be easy enough to extend this list. Thus, the old leaden pipes at the springs have yielded a crop of minerals similar to those which are obtained in lead veins, and including also some rare species, such as *phosgenite*; while the iron has, in like manner, been chemically acted upon, and yields *pyrites* and other ferruginous minerals. Even the masonry, the bricks and the concrete, which were used in the construction of the walls of the well, have yielded to the long continued action of the warm springs, and have given rise to certain silicates identical with native minerals.

Although the hot springs of Bourbonne-les-Bains offer, perhaps, the most striking known instance of chemical changes in historic times, it must not be supposed they are by any means an insolated case. Results of a like character were indeed obtained years ago by M. Daubrée from the Roman workings at the hot springs of Plombières in France. It is obvious that the study of these comparatively recent changes tends to throw much light upon the origin of mineral veins or lodes—a subject which, in spite of all that has been written, is still enveloped in much mystery. Just as the student of palæontology requires an acquaintance with recent forms of life in order that he may interpret the structure of his fossils, so the study of these modern changes is of service in aiding us to understand the reactions which have gone on in past ages, and have resulted in the formation of vast mineral deposits. After all, it is but a glimpse of these changes that we are permitted to take. If such results as those described above have been produced by the action of water near to the surface, what effects might we hope to witness if it were possible to penetrate to a greater depth in these thermal sources, where the temperature is much higher and the pressure greater, and where therefore the chemical reactions must needs be more energetic!—*Nineteenth Century.*

A NEW UNDERGROUND LAKE.

The Tlemcen *Courier* (Algeria) describes a wonderful discovery recently made at the picturesque cascades of that place. Some miners had blasted an enormous rock near the cascades, and on removal of the *débris*, found it had covered a large opening into a cave, the floor of which was covered with water. Constructing a rude raft and providing themselves with candles, the workmen sailed along this underground river, which at a distance of 60 meters was found to merge into a large lake of limpid water. The roof of the cavern was very high and covered with stalactites, the brilliant colors of which sparkled under the light of the candles. Continuing their course, the workmen had at certain places to navigate their craft between the stalactites, which, meeting stalagmites from the bed of the lake, formed enormous columns, which looked as if they had been made expressly to sustain the enormous arches. They thus reached the extremity of the lake, where they noticed a large channel extending toward the south, into which water quietly made its way. This is supposed to be a large fissure which has baffled exploration hitherto at Sebdon, and which connects the cascades with that locality, and thus with the mysterious sources of the Tafna. It is possible that here they have found an immense natural basin, supplied by powerful sources, and sending a part of its waters toward the lake, while the rest goes to Sebdon. The workmen estimated the distance underground traversed by them at three kilometers and the breadth of the lake at two. They brought out with them a quantity of fish, which swarmed round the raft, and which were found to be blind. —*London Times.*

[Continued from Supplement No. 200.]

Translated from *La Correspondance Scientifique.*

THE BEGINNING AND END OF THE WORLDS.

By Camille Flammarion.

IV.

THE RESURRECTION.

The principles of thermodynamics demonstrate that an aerolite which comes from the realms of infinity, to be precipitated into the sun, reaches the latter with the unheard of speed of 627,000 meters (390 miles) during the last second of its fall! The transformation of this motion into heat produces a temperature more than 9,000 times greater than that which would occur from the combustion of a mass of coal equal to that of the aerolite. Whether the aerolite be combustible or not, the combustibility would add almost nothing to the tremendous heat produced by its mechanical shock. If the earth should fall on the sun, she would increase the latter's heat to a sufficient degree to keep up the solar emission for 95 years! And we know how prodigious this emission is, since it is more than *two thousand million* times greater than the solar heat intercepted by the earth, and sufficient to cause to boil 2,900 million cubic myriameters, per hour, of water at the temperature of freezing. Well, then, if the earth should be arrested in her course around the sun, and slowly enough so that the heat caused by such an arrest should not reduce her to vapor, she would fall upon the sun, reaching the latter's surface in 64 days, and her union with the sun, although adding, so to speak, but an atom to the enormous mass of the "star of day," would furnish a quota of 95 years of emission of solar heat. The impact of Jupiter would furnish a quantity of heat equal to that of the solar emission during 32,000 years.

Well, then, when our sun shall be extinct, and roll through space as a dark globe, he will be able, phœnix-like, to arise from his ashes by meeting with another dark globe, and thus will be lighted again the torch of life for new worlds, which the laws of gravitation will detach from the nebula thus formed, as they once detached our present earth and her sisters from the nebula to which they belonged. At this moment the sun is sailing with great swiftness toward the stars of the constellation of Hercules. Every star is animated by an appropriate motion, which transports it, with its system, through immensity. Several of these motions are rectilinear. It is not impossible, then, for two stars to meet together in space; and perhaps that is the secret of the resurrection of worlds.

The earth and the planets will doubtless at this epoch have fallen in the sun. Created simply, says Tyndall, by difference in position of the masses which are attracted, the potential energy of gravitation was the original form of all the energy of the universe. As surely as the weights of a clock descend to their lowest position, from whence they can never remount unless a new energy be communicated to them by some as yet inexhausted source, so, in measure as the ages succeed each other, must the planets fall turn by turn on the sun. When one of them comes within some hundreds of thousands of miles of his surface, if it be still incandescent it must melt and be resolved into vapor through the effect of the radiating heat. Even should the planet, covered with a crust, be cold and externally dark, it would not be able to escape its terrible fate. If it does not become incandescent, like a shooting star, by friction in its passage through the atmosphere, the first grazing against its surface will produce an immense development of light and heat. Finally, either at the first blow, or after two or three bounds, like a cannon ball ricochetting on the surface of the earth or water, the whole mass will be ground up, melted, and reduced to vapor by a crepitation which will produce in a moment several thousand times as much heat as would a mass of burning coal of the same dimensions.

Whatever may be the definite fate of the theory that we have just sketched, it is much to be already able to establish the conditions that would certainly produce a sun, and to have been able to recognize in the force of gravity acting on a dark matter, the source from whence may have been derived the stars of the firmament. For, whether the sun has been produced, and his emission kept up by collision with cosmic masses, or whether the interior heat of the earth is the residue of the heat developed by the impact of cold, dark asteroids, it cannot be doubted that the cause assigned is capable of producing the effects attributed to it.

Perhaps it is a part of the general destiny of the universe that the sun should be directed toward a precise point that he will only reach after his death; and perhaps that is the final cause of the appropriate motion of all the suns in space. But we may at the same time conceive of a second process of destruction and resurrection, of which aerolites, shooting stars, and comets would be proof. From whence come the aerolites? From worlds that have been destroyed. How can a world become broken up in that manner? We do not know, and the fact appears to us even contrary to the laws of gravitation. But what is gravitation itself, in its essence? We do not know that either. Is this force of attraction absolute? Cannot bodies attain certain physical and chemical states in which gravitation is inert? What are these tails of comets that nearly always extend in a direction opposite to the sun? They seem to exhibit the action of a repulsive force, and are, consequently, contrary to gravitation. Well, let us for a moment admit that our globe, in consequence of secular cooling, solidification, and dryness, will one day crack into fissures, and that later on her constituent materials will cease to obey the force of aggregation which keeps them united, then our globe, rocky to her core, would be from that time formed of materials simply juxtaposed, and which would no longer be retained by any central force; like the corpse that, abandoned to the work of destruction, allows each of the molecules composing it the liberty of leaving it for ever in obeying thenceforward new influences. What will happen to this dead planet, to this corpse of the world? The moon's attraction, if it still existed, would alone take charge of the demolition, by producing a tide of pieces of earth, instead of a liquid one Let the other planetary perturbations be added, and there you have in a few centuries our poor disaggregated globe, its spheroidal form gone, scattering itself imperceptibly along its orbit. There you have the planetary system in fragments. All of that will go to fall pell-mell into the sun. And if such is likewise the final destiny of the sun, here we have this black star, himself disaggregated, and all the constituent particles of the solar system carried off into space to be scattered through the fields of heaven. This dust of worlds will float about in void until, some day, coming into the regions of a new resurrection, attracted by a fecund center, it will again be thrown into the crucibles of creation, and analogous cosmical dusts coming from all parts will unite at this same center to form by their universal fall a new focus of incandescence and creation.

The mathematician and physiologist, Helmholtz, admitting with Kant and Laplace that the nebulous matter of which the solar system was formed was at first of extreme tenuity, determined the quantity of heat that must have been engendered by the condensation to which we owe the existence of the sun, moon, and planets. In taking the specific heat of water for that of the condensing mass, the elevation of temperature produced by the mechanical formation of the sun would have been 28 million degrees! The ulterior condensation of cosmical dusts disseminated throughout space is also amply sufficient, then, for the creation of new worlds.

We may be positively certain, then, that Nature holds in reserve the causes of resurrection as she holds in her hand the causes of destruction. For her time is nothing. An act that requires a hundred thousand years for its accomplishment is as clearly determined and formed as an act which requires but a minute. Absolutely speaking, eternity alone exists, and time is only a relative form of it. As to our human personality and its immortality or its resurrection, a distinction should be made here between matter and spirit. Each of the constituent atoms of our body is indestructible, and constantly traveling from one association to another. Logic leads us to think that our virtual force, our psychic monad, our individual *ego* is equally indestructible, and more justly so. But under what conditions will it exist? Under what forms will it again become incarnate? What were we before birth, and what will become of us after death? Astronomy gives us the first answer worthy of the majesty of nature, and in close correspondence with our innate feelings. But this answer may be only the corollary of a psychological solution. Let philosophers imitate astronomers. Let them work on facts instead of speculating on words, and some day the veil of Isis will be entirely raised for our souls, which are so properly athirst for the truth. Positive science, science alone, will answer: *Life is universal and eternal.*

TIMBER IN BRAZIL.

Within an area of half a square mile, Agassiz counted 117 different kinds of wood, many of them admirably fitted by their hardness, tints, and beautiful grains, for the finest cabinet work. The muira-pinima, or tortoise-shell wood, undoubtedly the most precious wood in the world, is found in large quantity on the tributaries of the upper Amazon, where the water can be most easily applied as motive power. The pao de sangre, the rosewood, the pao de ferro (iron wood), or *Apuleia ferrea*, the various species of jacaranda known to natural history students under the names of *Dalbergia nigra*, *Mechaerium violaceum*, and *Platypodium elegans*, the white and black maraquatiara, the red maçaçauba, the pao santo or holy wood, and the sabuaranna—both of which are rivals of the most beautiful walnut—are wasted yearly on the Amazon in amounts ample enough to veneer all the palaces of Europe. Maurice Mauris, the explorer, believes that with the facilities which the Brazilian Government is ready to impart to enterprising industry, the export of these commodities would develop immense profits in the shortest time, while the capital invested need not be enormous. It is only necessary that these woods be introduced into the market to obtain a decided preference over those now most sought after in the two hemispheres. Still richer is the country in timber for the purpose of construction. The acapû (*Vouacapoua Americana*) is most plentifully found there, and often in the most imposing proportions. Mr. Mauris has seen dining tables six feet in width, made wholly out of one piece. This wood, like all its kindred maçaranduba and itauba, or stone wood, furnishes ship timber as durable as teak. The longer these remain in water the stronger and harder they become. The former will compare the more favorably with the teak, inasmuch as it is more compact. A pistol bullet which will pass through an inch board of teak wood, will not penetrate half an inch into a board of acapû. The itauba tree, too, offers many advantages over teak; it branches off naturally into keels and ribs of any size, and is lighter and more resistant.

A RARE IRISH ORCHID.

Visitors to the south-west of Ireland, on their way from Killarney to Cork by Glengariff, pass along the upper or inland portion of Bantry Bay. Generally content with the beauties of the scenery surrounding them, they seldom explore the remote recesses of this magnificent arm of the Atlantic. Some 24 miles from Glengariff, on the northern side of the bay, lies the picturesque village of Castletown, protected from the south-westerly gales by a long chain of hills some 900 ft. high, detached from the main land, called Bear Island. In the channel known as Bear Haven our fleet often rides securely at anchor. Here in a few sunny, sheltered spots, by the border of the sea, in little seaside meadows, there are now to be found in full flower specimens of a deliciously fragrant orchid—the sweet-scented lady's tresses. Each plant bears a stout spike of flowers of a cream-white color arranged in three series or rows, each flower being at least three times as large as those of the autumnal lady's tresses so commonly to be met with in the dry pastures of the south of England and Ireland at this season. By botanists it is called *Spiranthes Romanzoviana*. Sir Joseph Hooker once referred it to *S. cernua*, a species common in the United States, and till quite recently confounded with it by the American botanists. The chief charm or attraction in this little orchid is, however, its very peculiar geographical distribution. Except over a few acres near Castletown looking towards the south-west, it is not to be met elsewhere in the Old World. Unlike some of the rarer west of Ireland plants, it does not occur on the west coasts of Spain or Portugal; and yet cross over the Atlantic and it is to be met with in New York and thence on to the very borders of the Pacific.—*London Times.*